(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

AUGUST, 1903.

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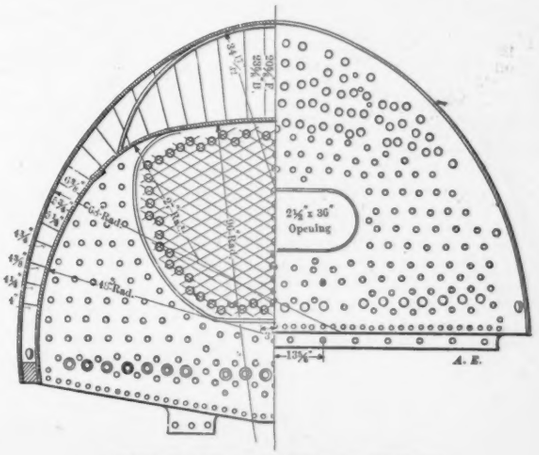
CULM BURNING PASSENGER LOCOMOTIVES.

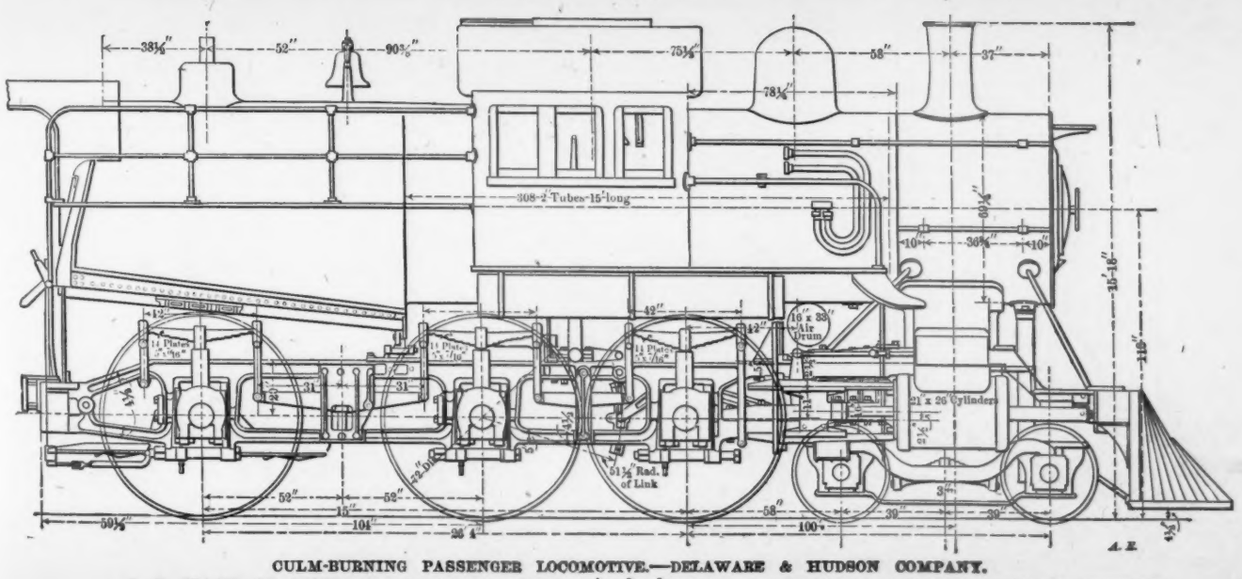
4—6—0 TYPE.—DELAWARE & HUDSON COMPANY.

This locomotive combines six coupled, 72-in. driving wheels, a 66-in. boiler and a 102-in. firebox, which is an unusual combination even on roads using fine anthracite. The engine may be compared with that of the same type on the Lehigh Valley, illustrated in October, 1900, page 312. The Delaware & Hudson engine is lighter in total weight by 19,750 lbs. and has but 45 sq. ft. less heating surface, the boiler being 2 ins. longer than that of the Lehigh Valley engine.

The Delaware & Hudson engine has a straight boiler, a water grate, a single wide fire-door and cast steel frames of I section, which were designed by Mr. Slack upon the basis of a



SECTION AND ELEVATION OF FIREBOX.



CULM-BURNING PASSENGER LOCOMOTIVE.—DELAWARE & HUDSON COMPANY.
J. R. SLACK, SUPERINTENDENT MOTIVE POWER. 4—6—0 TYPE. AMERICAN LOCOMOTIVE COMPANY, BUILDERS.

wide experience and close study of the failures of cast steel frames as ordinarily made. These frames have curves instead of sharp corners, and large fillets in all angles. These frames are strongly braced across the engine at the driving boxes and are made in I sections. Another feature of this engine is the application of the new Wilson high-pressure balanced valve. This engine has 9 x 13-in. driving journals.

The following ratios and table of dimensions will be found interesting:

Ratios.

Heating surface to cylinder volume	= 256.2
Tractive weight to heating surface	= 49.4
Tractive weight to tractive effort	= 4.85
Tractive effort to heating surface	= 10.17
Tractive eff. × diam. of drivers to heating surface	= 732.4
Heating surface to tractive effort	= 9.8 %
Total weight to heating surface	= 65.7

CULM-BURNING PASSSENGER LOCOMOTIVE.

4—6—0 TYPE. DELAWARE & HUDSON COMPANY.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Fine anthracite coal
Weight in working order	175,000 lbs.
Weight on drivers	131,500 lbs.
Weight engine and tender in working order	292,250 lbs.
Wheel base, driving	16 ft.
Wheel base, rigid	16 ft.
Wheel base, total	26 ft. 4 ins.
Wheel base, total, engine and tender	53 ft. 7½ ins.

Cylinders.

Diameter of cylinders	21 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	5 ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	Cast-iron rings
Kind of piston-rod packing	U. S. multiangular
Size of steam ports	18 in. x 1⅝ ins.
Size of exhaust ports	18 x 3 ins.
Size of bridges	1⅝ ins.

Valves.

Kind of slide valves	Wilson's American high-pressure
Greatest travel of slide valves	5½ ins.
Outside lap of slide valves	1 in.
Inside lap of slide valves	0 in.
Lead of valves in full gear	1-16 in.
Kind of valve-stem packing	U. S. multiangular

Wheels, Etc.

Number of driving wheels	6
Diameter of driving wheels outside of tire	72 ins.
Material of driving wheel, centers	Cast steel
Thickness of Tire	3½ ins.
Driving-box material	Cast steel
Diameter and length of driving journals	9 ins. diameter x 13 ins.
Diameter and length of main crank-pin journals, (Main side 7½ x 4¼ ins.)	6½ ins. diameter x 6½ ins.
Diameter and length of side-rod crank-pin journals	5 ins. diameter x 4¾ ins.
Engine truck, kind	4-wheel, swing bolster
Engine truck, journals	6½ ins. diameter x 12 ins.
Diameter of engine-truck wheels	33 ins.

Boiler.

Style	Culm burner
Outside diameter of first ring	66¼ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox: ½ in., 5/16 in., 21-32 in. and ¾ in.	
Horizontal seams	Butt joint sextuple riveted
Circumferential seams	Double riveted
Firebox, length	119⅞ ins.
Firebox, width	102 ins.
Firebox, depth	Front, 64 ins.; back, 42 ins.
Firebox plates, thickness: Sides, ⅝ in.; back, ⅝ in.; crown, ⅜ in.; tube sheet, ½ in.	
Firebox, water space	Front, 3½ ins.; sides, 3 ins.; back, 3½ ins.
Firebox, crown staying	Radial
Firebox, staybolts	Ulster special, 1 in. diameter
Tubes, number	308
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft.
Heating surface, tubes	2,405.5 sq. ft.
Heating surface, water tubes	78.54 sq. ft.
Heating surface, firebox	179.68 sq. ft.
Heating surface, total	2,663.72 sq. ft.
Grate surface	84.85 sq. ft.
Grate style	Water grate
Exhaust pipes	Double
Exhaust nozzles	3¼ ins., 3⅜ ins., 3½ ins. diameter
Smokestack, inside diameter	16 ins.
Smokestack, top above rail	15 ft. 1⅛ ins.

Tender

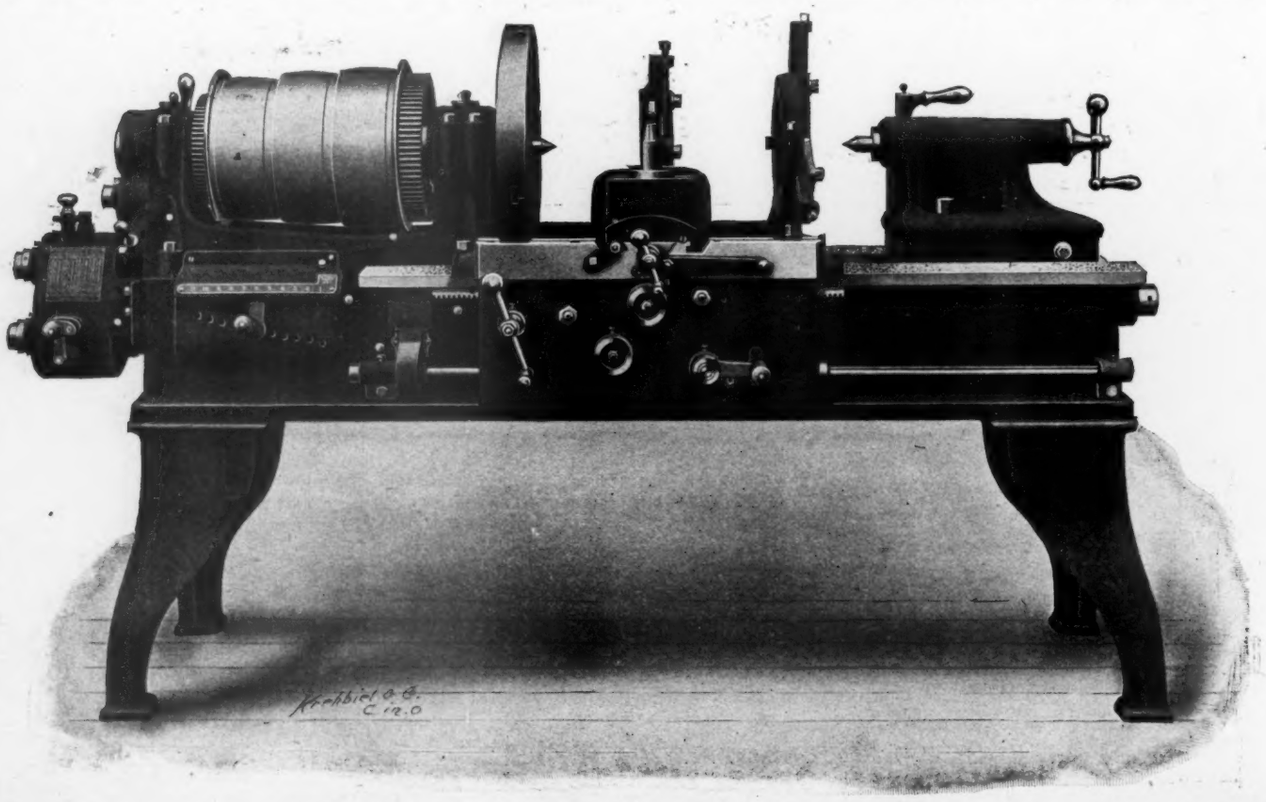
Style	8-wheel, water bottom
Weight, empty	47,100 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5 ins. diameter x 9 ins.
Wheel base	18 ft. 5 ins.
Tender frame	10-in. steel channels
Water capacity	6,500 U. S. gals.
Coal capacity	8 tons

A NEW EXTRA-HEAVY HIGH-SPEED LATHE.

THE AMERICAN TOOL WORKS COMPANY.

The use of the new high-duty tool steels for rapid machining processes has been very effective in exposing the limitations of the very best modern machine tools and in suggesting advantageous improvements in design. The improvements in the heavy and rapid machining processes thus made possible have been readily appreciated by the American Tool Works Company, Cincinnati, Ohio, who have been foremost in adapting their designs to conform to the new practice.

In the above engraving is illustrated an interesting new type of lathe which has recently been placed upon the market



NEW HIGH-SPEED LATHE.—AMERICAN TOOL WORKS COMPANY.

by the American Tool Works Company, which they have termed the "American" high-speed lathe. The principal feature of this lathe is that it has been designed particularly for high-speed cutting on work from 1 to 4 ins. in diameter. It has been designed throughout to meet the special requirements of modern high-speed tool steels; it has been the aim to place the limit of work at the cutting tool rather than at the belt, and with this point in view the apron, carriage and bed and other details have been given exceptional strength and the headstock has been endowed with enormous belt power—such that the contact of the belt when on the smallest step of the cone is greater than that on the ordinary 36-in. lathe.

The belt cone is so designed that a 4-in. double belt can be shifted to any of the three steps with the greatest facility. There are twelve changes of speed in the drive, so graded that a cutting speed of 160 ft. per minute can be maintained on work ranging from 1 in. to 4 ins. diameter. The bearings, owing to the very high spindle speeds, are of unusual size, made of phosphor bronze, and are self-oiling.

This lathe is equipped with their new rapid change-gear feeding mechanism, which was described on page 43 of our April, 1903, issue. This gear mechanism is a positive drive in either direction and is capable of feeding up to the limit of the belt power. Through the four-speed box at the end of the bed operating in conjunction with the cone of eleven gears mounted on the inside of the bed, a range of 44 changes for feeding and screw cutting is easily available, while the machine is in operation and without the removal of a single gear.

The bed is of a patent drop V pattern, which gives 2 ins. additional swing without raising the head and allows placing a great deal of extra metal in the bridge of the carriage. The lead screw is placed on the inside of the bed, bringing the pull directly under the cutting tool, thus centralizing the strain and obviating all that tendency to twist, so common in lathes with the screw on the outside.

An elaborate series of tests was recently performed on this machine, which we are enabled to present. The cuts were taken with a well-known brand of high-speed tool steel, on bars of commercial machinery steel; in each experiment the tool was tested to the breaking-down point. The actual results derived are presented below, showing the cutting speed in feet per minute at the moment of the breaking down of the tool:

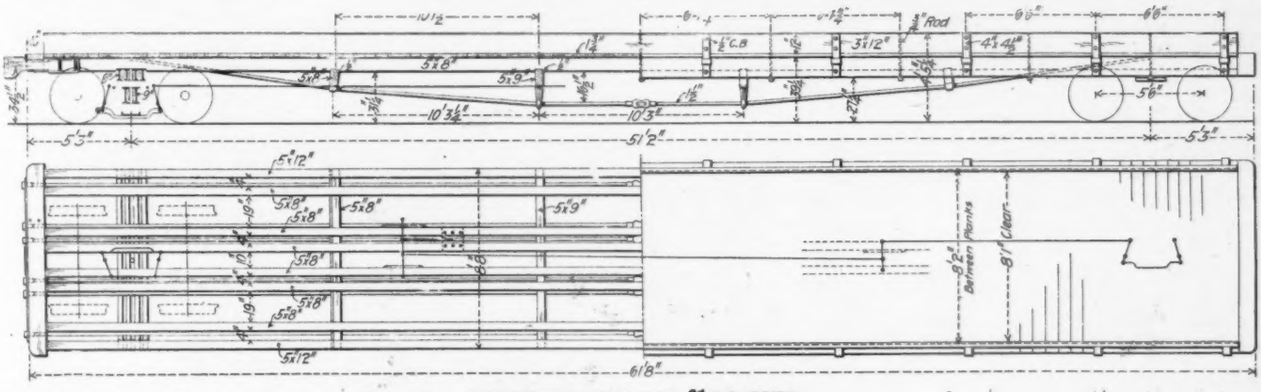
RESULTS OF THE TESTS.

Test No.	Feed, ins.	Depth of Cut	Cutting Speed—ft. per min.	Test No.	Feed, ins.	Depth of Cut	Cutting Speed—ft. per min.	Test No.	Feed, ins.	Depth of Cut	Cutting Speed—ft. per min.
1	1-64	1-16	326	10	1-64	3-32	326	19	1-64	1/8	336
2	1-64	1-16	425	11	1-64	3-32	368	20	1-64	1/8	326
3	1-64	1-16	339	12	1-64	3-32	332	21	1-64	1/8	310
4	1-32	1-16	320	13	1-32	3-32	230	22	1-32	1/8	250
5	1-32	1-16	360	14	1-32	3-32	268	23	1-32	1/8	260
6	1-32	1-16	354	15	1-32	3-32	285	24	1-32	1/8	267
7	3-64	1-16	381	16	3-64	3-32	262	25	3-64	1/8	231
8	3-64	1-16	327	17	3-64	3-32	209	26	3-64	1/8	220
9	3-64	1-16	330	18	3-64	3-32	227	27	3-64	1/8	240

It may be seen from the above that a very high rate of cutting speed was attained throughout, in some instances being truly remarkable, considering the fact that it was on a roughing cut. The lathe withstood this exceptionally heavy duty without a sign of distress. This goes to prove the trend of modern possibilities in rapid work production.

A 30-TON FLAT CAR 61 FEET LONG.

This long flat car was built by the Middletown Car Works, Middletown, Pa., for a circus troupe. It is 61 ft. 8 ins. long over end sills, and 8 ft. 8 ins. wide over side sills. The floor system is built upon eight horizontal sills in pairs, of which all but the side sills are 5 by 8 ins., and the side sills are 5 by 12 ins. Six 1½-in. truss-rods extend from end sill to end sill, and in addition to the usual needle beams there are two additional cross tie timbers, against which the truss-rods are seated. The body bolsters are very shallow, and are made of four 5½-in. I-beams, with wooden filling blocks, forming a bolster 18 ins. wide. These bolsters are let into the longitudinal sills a distance of ½ in. The truck bolsters are of two 9-in. I-beams, with wood fillers. With the low sills and shallow bolsters the height of the under faces of the side sills above the rail is but 27¼ ins. The brake-shaft arrangement at the end sills is designed to permit the shaft to drop down out of the way when not in use. The shaft is of 1¼-in. square iron, resting in a cast sleeve, with the ratchet wheel attached. It is secured to the end sill. We are indebted to Mr. George I. King, vice-president and general manager of the Middletown Car Works, for the drawing.



THIRTY-TON FLAT CAR, 61-FT. LONG.

"A Few Points on Grinding" is the title of an excellent pamphlet treating of the subject of machine grinding that has recently been published by the Norton Emery Wheel Company, Worcester, Mass. It contains a reprint of an excellent article which appeared in a recent number of the *American Machinist*, by Mr. Charles H. Norton, of the Norton Grinding Company, an acknowledged authority upon the subject of machine grinding. In this article Mr. Norton makes many very interesting and quite radical statements. He lays particular stress upon the importance of selecting the proper grade of emery wheel for every class of work. He states: "The manager or foreman who casts aside this matter of wheel selection for various work will be left behind in the race, and the cool-headed thinker who gives the matter patient and unprejudiced investigation will be rewarded by large returns." He enforces the fact that machine grinding is useful for more than mere polishing by the statement that "late experience shows it to be practicable to remove 1 cubic inch of steel per minute from cylindrical work by grinding with suitable wheels." This pamphlet should be in the hands of all who are interested in modern machine shop practice, as "there are signs that very much work now done by cutting will be done by grinding, and those soonest informed upon the subject will profit most by it."

A run of 299 miles from London to Carlisle without an intermediate stop has been made on the London & Northwestern Railway, the time being 5 hours, 58 minutes.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

VIII.

BY C. W. OBERT.

In drilling machines the capacity of the tool is largely dependent upon the rapidity and accuracy with which the driving speed may be changed for adjusting drill spindle speeds to the maximum rates for the various sizes of drills used. The importance of providing a wide range of speeds upon the drive, which are very easily accessible to the operator for this purpose, cannot be overestimated. The Wm. E. Gang Company, Cincinnati, Ohio, have appreciated this need and have recently perfected a new design of radial drill which embodies the desirable feature of a variable-speed drive, the mechanism for which is described in this article.

The principal idea embodied in the design of this device is that of affording a means of getting a greater number of driving speeds than is usually obtainable from cone-pulleys, and of facilitating the changing of speeds. There is one feature which is particularly worthy of note: that is, the ability to reach and control the speeds directly from one point without having to operate a number of levers at different parts of the machine in connection with an index plate. The loss of time incident to an arrangement where the operator is required to read a set of directions and then manipulate a number of levers and gears on different parts of the machine in accordance with those directions is liable to be considerable.

The variable-speed mechanism is illustrated in the engravings, Figs. 39 to 42, and in section in Fig. 43. The general principle mechanically of the device is that of making use of several trains of gears which are capable of several different gear combinations, but the system of clutching and operating levers is decidedly novel. As will be noticed in the engravings, there are three sets of gears of three gears each, a total of nine gears, giving nine speeds, and this number is doubled by the back gears on the spindle of the drill. The gears, ABC,

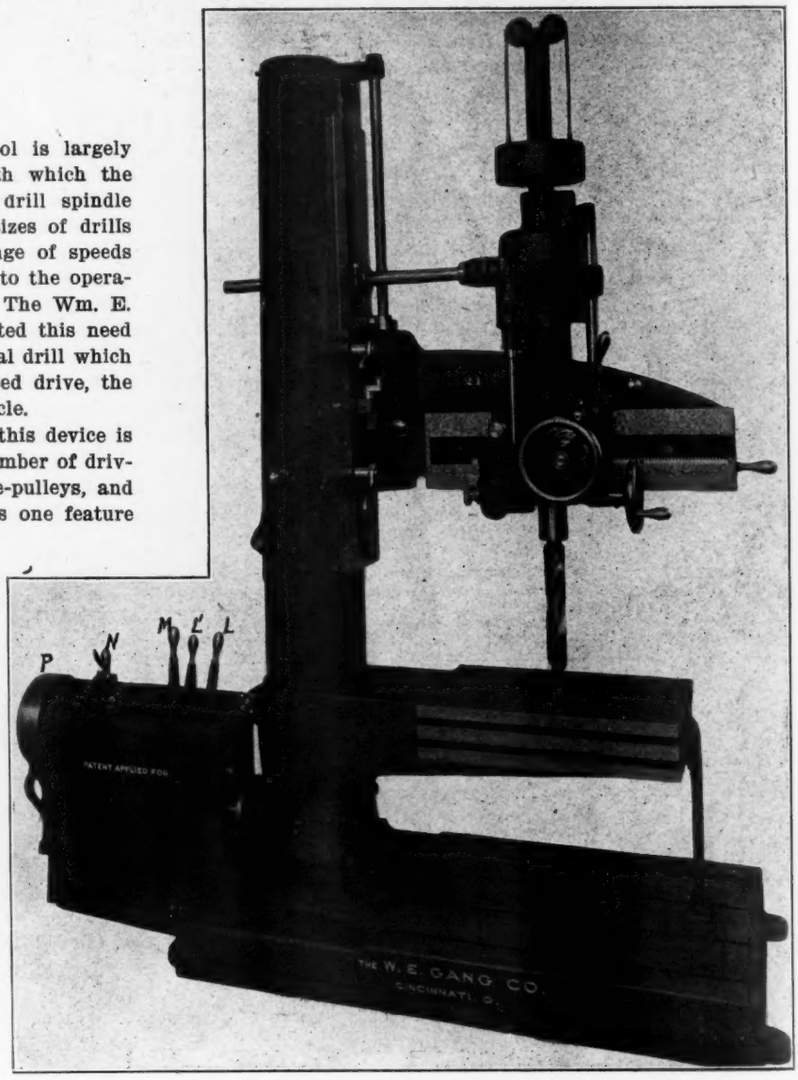


FIG 39.—NEW RADIAL DRILL WITH VARIABLE SPEED DRIVE.—WM. E. GANG COMPANY.

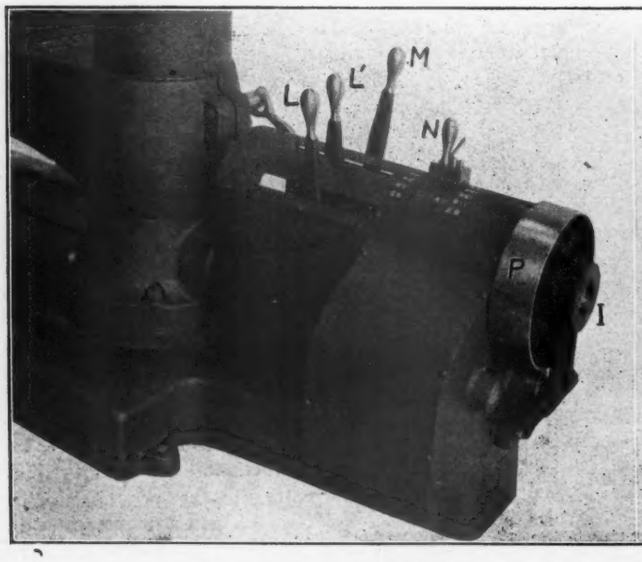


FIG. 40.—REAR VIEW OF THE SPEED BOX, SHOWING CASING FOR INTERMEDIATE GEARS.

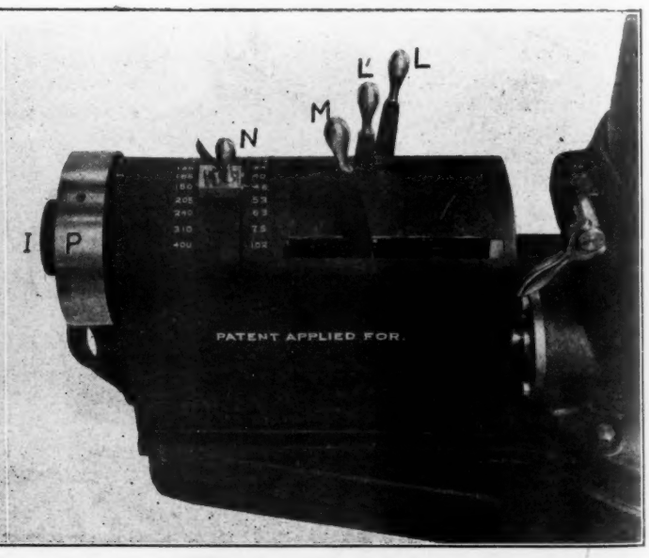


FIG. 41.—FRONT VIEW OF SPEED BOX, SHOWING OPERATING LEVERS AND SPEED INDEX.

are mounted loosely on shaft S, and gears, D E and F, are mounted loosely on shaft S'. Shafts, S and S', are carried in journals at the ends and are free to slide through the gears and journals. The intermediate gears, X Y and Z, are fast on

a shaft and mesh respectively with A D, B E and C F. This gives three trains, thus, AXD, BYE, and CZF.

The shafts, S and S', carry friction rings, O and O', which are operated by means of the sliding wedges, W, and loose collars, G and G'; ring, O, engages in the bores of gears, A B and C, and O' in the bores of gears, D E and F. The driving pulley, P, has a long hub which is journaled in the frame, H, and bracket, I, and is feathered on shaft, S. The dogs, Q and Q', act as fulcrums for the levers, L and L', being loosely mounted

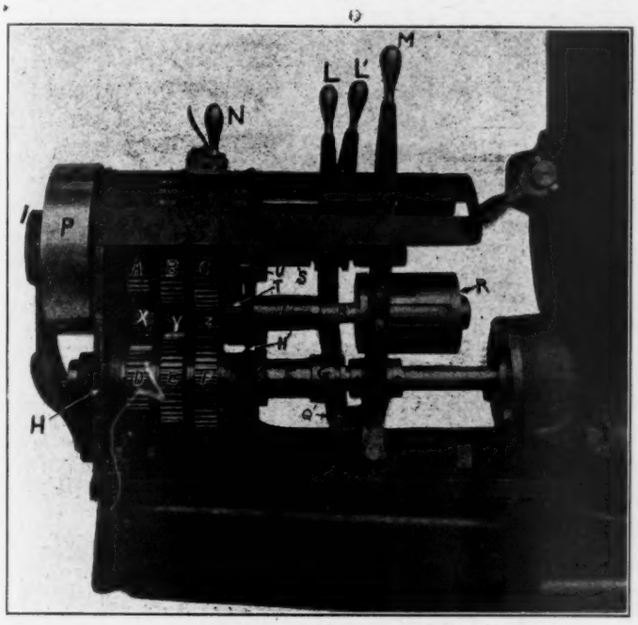


FIG. 42.—INTERIOR VIEW OF SPEED BOX, SHOWING SLOTTED CONTROLLING DRUM.

of shaft, K, and segments, T and U, connected to handle, N. When handle, N, is in position for the speed required, the lever, M, is drawn to the position, 2, as indicated by the full lines, in Fig. 43. This movement locates the friction clutches in the proper gears to give the required speed, and the friction clutches are then set by means of levers, L and L'. The speeds available for the different adjustments of drum, R, are indicated by numbers on the case near handle, N, as shown in Figs. 40 and 41.

The friction rings are operated by taper keys, as shown at W, in the clutch detail in Fig. 43. The action of the lever, L or L', is to force the keys forward and spread the ring, O or O', until it engages with the gear surrounding it. The method of retaining the friction rings in their places upon shafts, S and S', by means of a taper pin, as shown in the detail view, is decidedly interesting.

The design of this device displays remarkable ingenuity. It is very easily operated and embraces a wide speed range, giving as it does a range of 25 to 400 revolutions per minute at the spindle. We are pleased to state that this mechanism has been in service for a very considerable time with very satisfactory results and has proven very effective.

Most satisfactory performance of Babcock & Wilcox boilers on the "Marietta" is recorded by Ensign Henry C. Dinger, U. S. N., in the *Journal of the American Society of Naval Engineers*. The performance of this vessel in the famous run from the Pacific Coast to Cuba in the recent war was sufficient to establish a record for these boilers, but since that time the ship has been in continuous service in the waters of China and the Philippines. "Probably no vessel in the navy during the past five years has steamed as many miles, for the 'Marietta' has logged over 80,000 knots during that period." The repairs have been surprisingly light and they have nearly all been done by the ship's boilermaker and his helpers. This country has

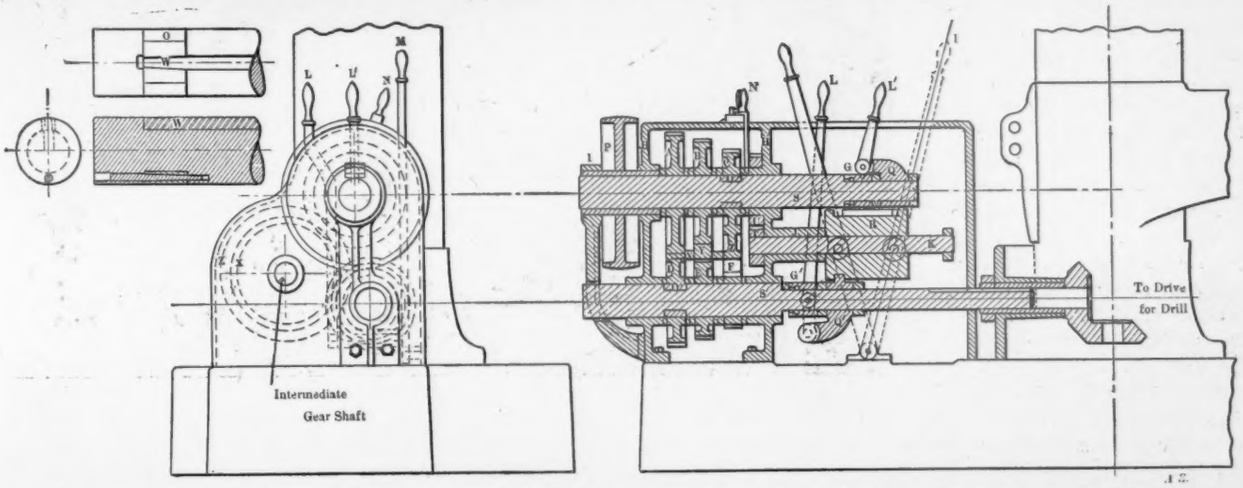


FIG 43.—SECTIONAL VIEW OF SPEED BOX, SHOWING ARRANGEMENT OF GEAR TRAINS AND DETAILS OF FRICTION CLUTCHES.

between collars on shafts S and S', and have projections which engage in the grooves in drum, R; see Figs. 42 and 43.

The drum, R, which is feathered on shaft, K, has one annular groove turned near the end connecting with six long and six short longitudinal grooves. The splined shaft, K, journaled at J, carries a gear segment, T, fast on one end, by which drum, R, on the other end, is rotated. Gear segment, T, meshes with another gear segment, U, which is mounted loosely on the journal of frame, H'. This arrangement is such that the projections on the dogs, Q and Q', engage in slots on opposite sides of drum, R, and the action in indexing to obtain a given speed is as follows:

Lever, M, is drawn to position, 1, as indicated by the dotted lines in Fig. 43, thereby sliding the drum, R, which by means of the grooves engaging the dogs, Q and Q', draws shafts, S and S', with it. The friction clutches are now in gears, C and F, and the projections on dogs, Q and Q', being in the annular groove in drum, R, permits the drum to be revolved by means

not only escaped the uncomfortable and expensive experience of some other nations in the boiler question, but we seem to be ready to begin a development which promises successful and entirely satisfactory results and with no expensive failures to live down. This record of the "Marietta" is remarkable, and it should be borne in mind in connection with the question of water tube boilers in other classes of exacting service.

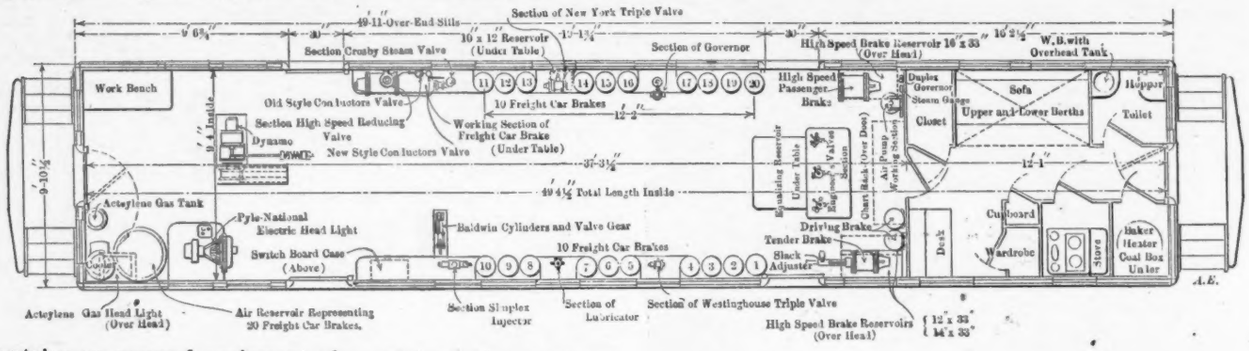
The real desideratum which is achieved by the application of electric-motor driving is the increased output from the machinery—this far outweighs in importance the several other advantages incidental to electric driving, such as the saving of head-room, the absence of long lines of shafting, the avoidance of power wastes, etc. In reality economy of power is of little importance, inasmuch as its value, whether furnished by shafting or by a motor, is nearly negligible when compared with the importance of increased product.

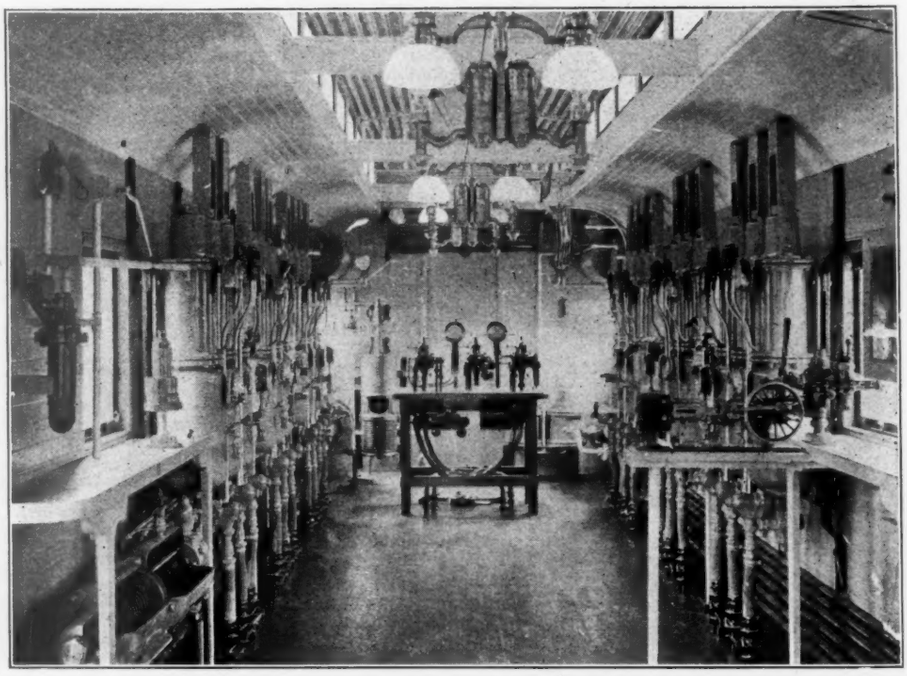
INSTRUCTION CAR.

Atchison, Topeka, & Santa Fe Railway.

The Santa Fe has recently equipped a new instruction car, the arrangement of which is shown in the accompanying plan. A postal car 50 feet long was rebuilt for this purpose and it contains an unusual equipment of apparatus, a large proportion of which is working mechanism, and this is accompanied by other apparatus sectioned in order to facilitate instruction. Notations on the plan indicate the location and description of the apparatus, making a list of the features of the equipment unnecessary. It includes the high-speed brake, electric headlight and turbine, injectors, and the ordinary brakes. As this road has a large amount of electric-lighting apparatus for passenger cars with generators driven from the axle, a generator is placed in the car for instruction purposes. About 100 cars are now running on this road with "axle light." Instead of being hung from the truck in the usual way, this generator is mounted on the floor of the car so that it may be studied and described. It also serves to light the car, and represents the equipment as it is actually in use. Instead of providing a compressor, this car is supplied with compressed air from a locomotive or from the yard piping systems at terminals where it is stationed. We are indebted to Mr. G. R. Henderson, formerly superintendent of motive power, for this information.

Quantzintecomatzin is the name of a car operated by the American Tourist Association. This car is said to have the usual number of truss rods, but there must be some concealed steel work in the frame in order to carry such an extraordinary load. "What's in a name?" There appears to be everything in this one.





AIR BRAKE INSTRUCTION CAR.
ATCHISON, TOPEKA & SANTA FE RAILWAY.

MOTOR-DRIVEN MACHINE TOOLS.

The Latest Practice in Applying Individual Drives to Shapers.

In the July issue there were illustrated, in an article appearing under the above heading, a number of interesting applications of motor driving to shapers. We have often heard the opinion offered that it is entirely unnecessary to attempt the application of motor-driving to tools as small as shapers, but the importance that is coming to be attached to this use of motor-driving can best be judged from the number of motor-driven shapers that are being developed by the most prominent machine-tool builders. In this article are supplemented further interesting examples of motor-drive applications to shapers, for both constant-speed and variable-speed driving.

The upper engraving on page 291 represents two views of a very interesting type of motor-drive that the Hendey Machine Company, Torrington, Conn., are applying to their pillar shapers. The shaper here illustrated is the 24-in. Hendey rack shaper with friction-clutch drive. The support for the motor is very conveniently provided for by a small cast iron bracket which is bolted to the rear of the machine's frame, thus in no way necessitating any alteration in the construction of the tool. This bracket is provided with V-ways and an adjusting screw to permit of moving the motor foot-plate for tightening the belts. A valuable feature of this method of mounting the motor is that of the small amount of additional working space required by the tool when thus equipped.

The motor used in this drive is a 2-h.p. direct-current multipolar motor, of the back-geared type, built by the Northern Electrical Manufacturing Company, Madison, Wis. The back-geared motor is particularly advantageous for driving a rack shaper, as while the low speed of the back-gear shaft is adapted for the forward, or cutting stroke of the ram, the high speed of the armature shaft is directly applicable to the quick-return motion of the ram, and the directions of rotation harmonize. This is carried out in the drive by belting from the armature

shaft direct to the quick-return pulley and from the back shaft direct to the forward-motion pulley, the necessity of crossing belts being thus dispensed with entirely. The back-shaft speed is properly reduced to admit of the use of the same sized driving pulley as regularly used, thus affording full power to the cutting stroke. Two different cutting speeds are also available at the ram by means of the two-stepped cone pulleys on the forward-motion drive.

The motor operates at a constant speed, at its maximum efficiency; it is controlled by a main switch and a starting box at the right side of the frame, conveniently accessible to the operator. The starting box is covered by a small hooded shelf for protection from metal chips, dirt, etc., from falling upon it, as shown. The sizes of motors recommended by the Hendey Company for their various sizes of shapers are as follows:

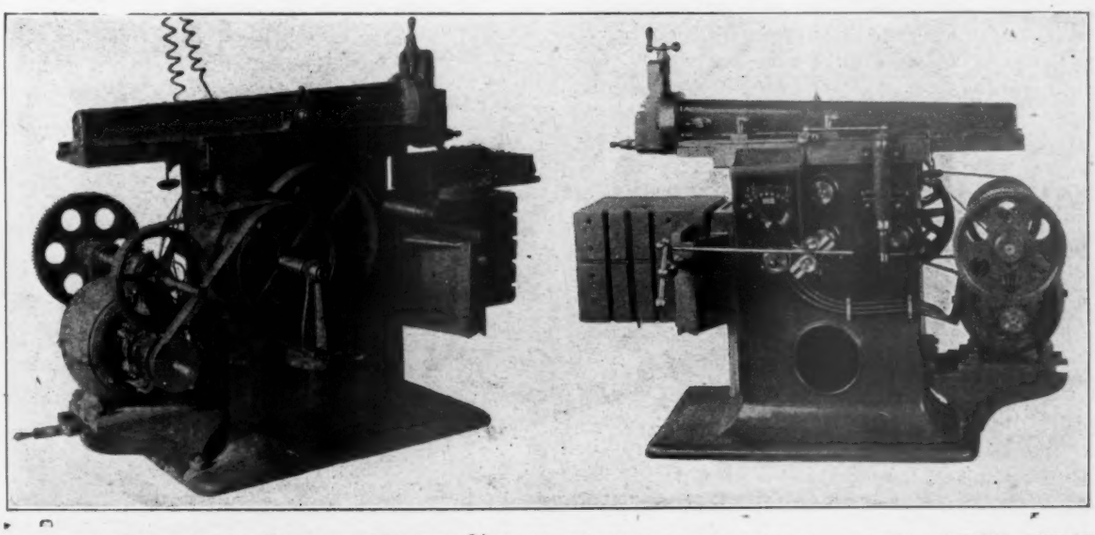
Size of Shaper.....	15 in.	20 in.	24 in.	28 in.
Horse Power of Motor.....	One	Two	Two	Three

The engraving on page 292 illustrates a very interesting motor-drive application upon a shaper which is similar to the above in principle. The machine shown is the 30-in. geared, draw-cut shaper, built by the Morton Manufacturing Company, Muskegon Heights, Mich. The motor in this case also is supported by a bracket at the rear of the frame, although no motor adjustment for belt tightening is here necessary. The drive is made through a countershaft which is permanently mounted above the pillar upon a neat bracket or stand.

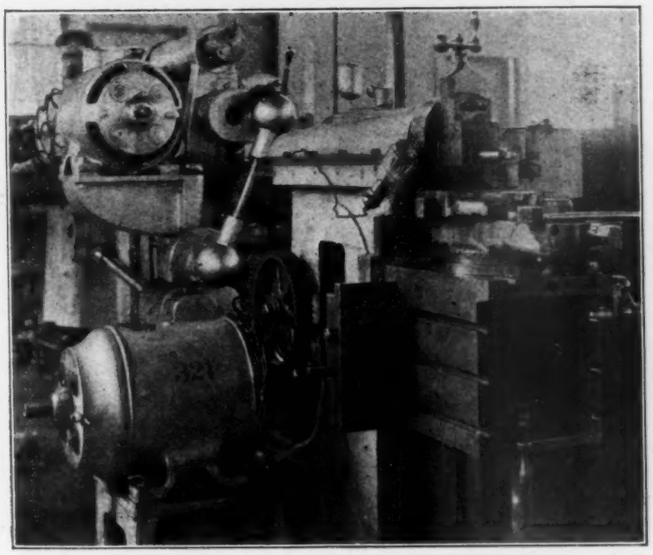
The motor used for this drive is also a constant-speed direct-current motor, being in this case furnished by the General Electric Company. It is controlled by a starting box and main switch, both of which are located on the right side of the frame for convenient access to the operator. The drive is further made flexible by the use of a friction-clutch on the countershaft for starting and stopping the machine independent of the motor. The reciprocating motion is obtained for the ram by open and cross belts and special automatic-relieving clutches, the driving pulleys being proportioned for a quick-return stroke of 3 to 1.

The principle for which this shaper is particularly noted is that of the "drawing" cut, whereby the thrust of the cut is placed directly against the column of the machine, thereby having a tendency of drawing the bearings closer together and making the machine more accurate. The construction of the machine is such that it will work close to a line and will reverse at the extremity of its stroke without shock or jar. It is of the geared type and gives an even motion through the entire cutting stroke. The gearing throughout is cut from the solid, and the stroke is adjusted by tappets on a circular disc. On ordinary cast iron work a cut 1 in. deep with 1-13-in. feed is carried by this machine with ease.

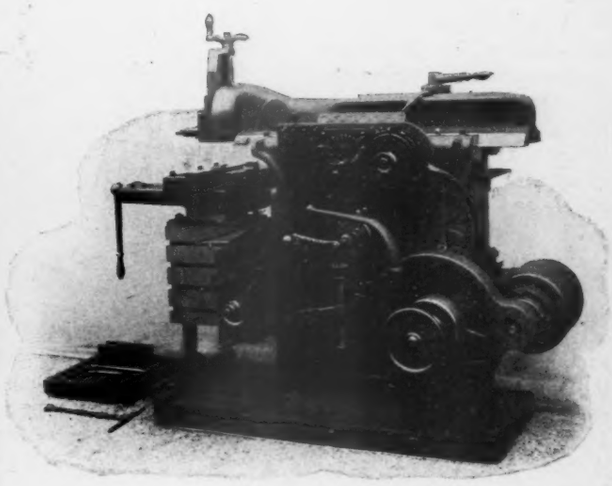
The Morton Manufacturing Company have made several experiments in applying motor drives to their different tools and have always found it advisable to employ a belt drive from the motor for their particular line of tools. They use



LEFT AND RIGHT-HAND VIEWS OF MOTOR-DRIVEN 24-IN. HENDEY-NORTON RACK SHAPER.—HENDEY MACHINE COMPANY.



VARIABLE-SPEED GEARED DRIVE, 16-IN. SMITH & MILLS CRANK SHAPER AT THE WORKS OF THE BULLOCK ELECTRIC & MANUFACTURING COMPANY.



VARIABLE-SPEED GEARED DRIVE UPON THE "QUICK-STROKE" SHAPER BUILT BY GOULD & EBERHARDT.

friction clutches for obtaining the reciprocating motion for shapers and find that they thus obtain better results, as there is a slight chance for slippage of the belts.

The lower right-hand engraving on page 291 is an illustration of the latest type of variable-speed drive which has been developed by Gould & Eberhardt, Newark, N. J., for their new "quick-stroke" shaper. The motor is in this case very conveniently mounted upon the rear of the pillar and drives the crank-gear shaft through a rawhide pinion on the armature shaft, and a friction clutch, which is operated by the large handle at the front of the machine. The space occupied by the drive is very small and it is to be noted that no special bracket is required to support it.

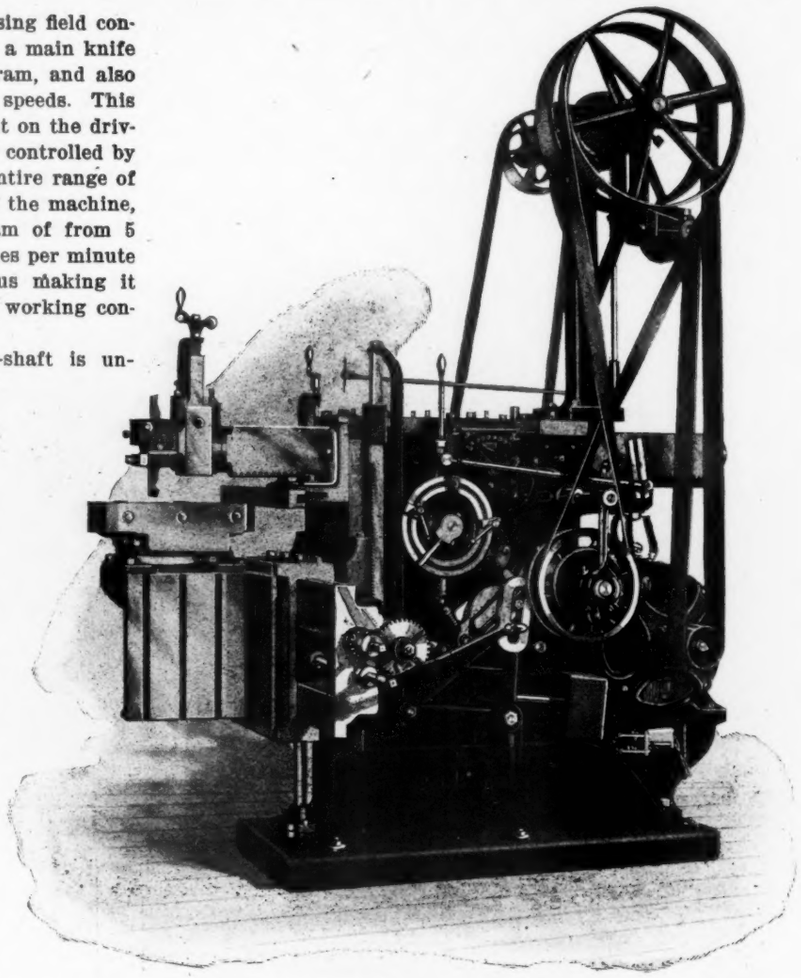
The motor is a Storey variable-speed motor, using field control for the range of speeds. It is controlled by a main knife switch and a starting box at the right of the ram, and also there is added a rheostat for the field control of speeds. This speed range is doubled by a back-gear attachment on the driving shaft which is easily operated by a slip gear controlled by a handle above the motor. The motor and the entire range of speeds are thus easily handled from the front of the machine, the entire range of speeds available at the ram of from 5 strokes per minute when back geared to 100 strokes per minute single geared being very easily obtainable, thus making it possible to vary the tool speed to best suit the working conditions for performing short operations.

To make the back-gear change, the pinion-shaft is unclutched by a slight movement of the clutch-lever at the front of the machine, which lever operates also a brake, enabling the machine to be stopped immediately; after throwing over the slip-gear for the back-gear the clutch is thrown in again. The large hand-wheel on the outer end of the pinion-shaft, in front of the clutch, gives a convenient hand movement of the ram for use in setting the tool. An important feature of the drive of this tool is that all shafts run in cylindrical bushes held in bored seats in the frame, so that they may be cheaply and easily renewed without change of the original alignment.

The remaining engraving on page 291 illustrates a variable-speed drive that has been applied to a 16-in. Smith & Mills crank-shaper at the works of the Bullock Electric and Manufacturing Company, Cincinnati, Ohio. The method of mounting the motor here used is that of supporting it upon a small cast-iron platform at the left of the tool so as to permit the motor to gear direct with pinion-shaft gear. This makes a very simple and direct drive, and requires but little space.

The motor is one of the standard type N Bullock motors, operating on the multiple-voltage system. It has a maximum speed of 950 revolutions per minute with a voltage of 250 volts, and has a capacity of 2¼-h.p. The variable speeds are obtained through the agency of a multiple-voltage controller which is mounted at the right of the ram, as shown. In this way a wide range of speeds is available without back gear or gear changes, and it is easily changed from the front of the machine.

In the background in the latter engraving is shown an interesting variable-speed motor-drive upon a milling machine built by the Cincinnati Milling Machine Company. The motor, a type N multiple-voltage Bullock motor, is mounted upon a bracket at the rear of the headstock and is geared direct to the spindle.



BELTED COUNTERSHAFT DRIVE UPON 30-IN. GEARED DRAW-CUT SHAPER.—MORTON MANUFACTURING COMPANY.
CONSTANT-SPEED MOTOR.—GENERAL ELECTRIC COMPANY.

IDEAL SMALL CAR REPAIR SHOP.

Mr. G. N. Dow, master car builder of the Lake Shore & Michigan Southern Railway at Cleveland, presented before the Master Car Builders' Association a description of what he considered an ideal arrangement for a repair shop for a yard handling 2,500 cars per day. The plant is at Ashtabula, Ohio.

This arrangement consists of three long tracks holding 30, 33 and 46 cars, two short tracks used for heavy repairs holding 12 cars each and one short track holding 14 cars for loading and unloading material. The short tracks are located between the long tracks and each end of the building. There is also centrally located between the long tracks a building 216 ft. long and 26 ft. wide, a shed 100 ft. long and 16 ft. wide, which is used for storing manufactured material such as couplers, bolsters, end sills and draft timbers, a scrap bin 50 ft. long and 14 ft. wide, also a platform for storing wheels; two buildings 60 ft. long, 9 ft. wide and 7 ft. high, located south of the tracks and in the center of the plant. One is used as a mess-room, being equipped with lockers for men's clothes, two long sinks and benches; the other building is used for storing the men's tools and is equipped with shelves or racks. Parallel with each long track and between the short ones there is an 18-in. gauge track equipped with low four-wheel cars used for distributing material, tools and wheels. The general foreman's office is located in the southeast corner of the building. This entire plant is equipped with air, using 1¼-in. pipe having connections every 100 ft. apart for testing cars. The entire yard, including the space between the tracks, is planked with 2½-in. oak plank, which is easy to keep clean, and gives the entire plant a neat appearance and also gives a good foundation for jacks when jacking cars. It also reduces the labor in changing wheels, besides assuring a dry yard for the men to work in.

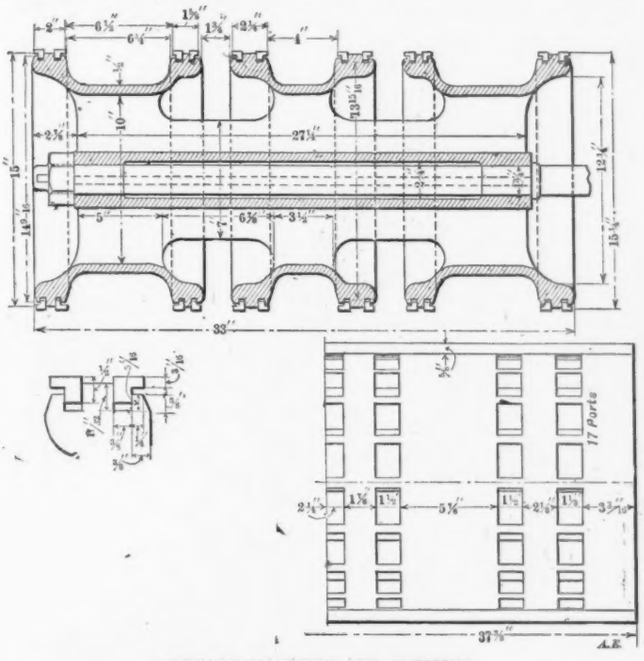
We repair at this plant on an average of 200 cars every working day with a force of 60 men. All classes of repairs are made, from changing couplers to rebuilding complete. For the last five months we have averaged per month 400 couplers changed, 126 pairs of wheels changed and 104 longitudinal sills applied. The month of March, 1903, was our heaviest month for wheels and sills, changing 199 pairs of wheels and 196 longitudinal sills.

PISTON VALVE FOR FOUR-CYLINDER BALANCE COMPOUND.

BALDWIN LOCOMOTIVE WORKS.

In illustrating the Vauclain balanced compound locomotive, built for the Plant System (AMERICAN ENGINEER, March, 1902), the valve was omitted from the details because it merited an explanation which could not be given at that time. The details of this valve are of greater interest because of the recent construction of four locomotives on the same system for the Atchison, Topeka & Santa Fe Railway.

The accompanying drawing of the valve and bushing and the sketch showing the cylinders and ports makes its operation clear. The simple construction is worthy of record. One valve, 15 ins. in diameter, serves both cylinders on one side of the engine. The valve is hollow and very light. It takes



DETAILS OF VALVE AND BUSHING.

steam at the center and places the valve stem under receiver pressure only. By following the courses of the arrows the operation of the valve is made clear and it should be noted that the ports to the low pressure cylinder are very short, giving to that cylinder very small clearances. This valve has been patented by Mr. S. M. Vauclain, of the Baldwin Locomotive Works. It is illustrated now because of a request from a correspondent who has become interested in the recent articles in this journal on the subject of the four-cylinder compound in France.

PERSONALS.

Mr. G. R. Henderson has resigned as superintendent of motive power of the Atchison, Topeka & Santa Fe Railway.

T. A. Mackinnon, first vice-president and general manager of the Boston & Maine Railroad, died suddenly July 12 at Marblehead, Mass.

George S. Morison, engineer of nine bridges over the Mississippi and Missouri rivers, and many other equally important works, died in New York July 1.

Mr. E. D. Nelson has been appointed engineer of mechanical and electrical tests of the Pennsylvania Railroad, with headquarters at Altoona. This is an office created to meet the need for an experienced officer who can take the entire responsibility for the important investigations which this road conducts in the study of its problems. The fact that the road is building a locomotive testing plant at Altoona and that the dynamometer, building at the works of Wm. Sellers & Co., is to have a capacity of 80,000 lbs., indicates the broad scope of the development which Mr. Nelson is to have in charge. He is transferred to this position from that of superintendent of motive power of the Philadelphia & Erie Division at Williamsport, Pa. He is succeeded by Mr. R. K. Reading, master mechanic at West Philadelphia.

Pulaski Leeds, superintendent of motive power of the Louisville & Nashville, was fatally shot by an employee of the road July 6 and died the next day. The shots were fired by G. B. Werner, electrician of the road, who immediately committed suicide. This sad affair removes one of the best-known motive power officers of the country. He was a large man and big-hearted, although his kindly nature was not always seen through a sometimes bluff manner. Several years ago the

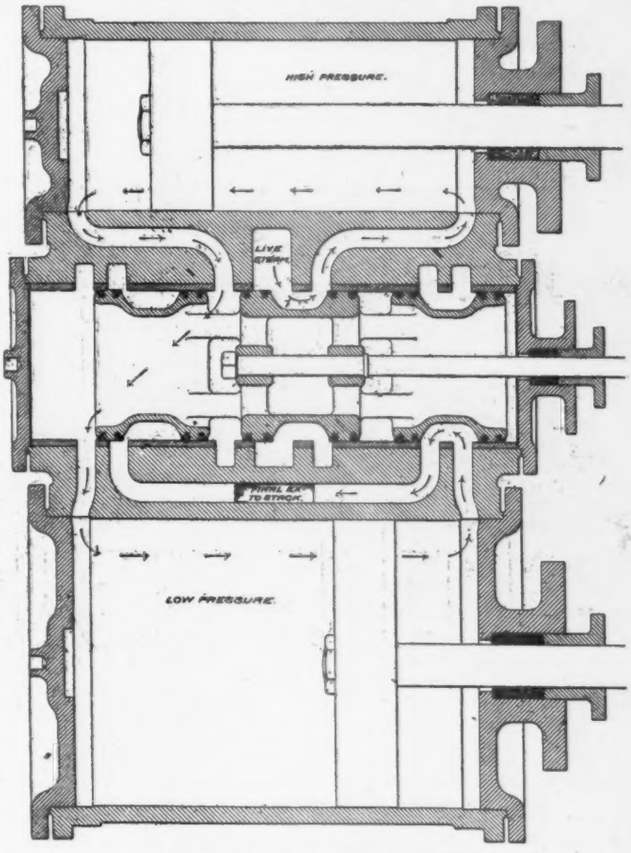


DIAGRAM OF VALVE AND CYLINDERS.

writer had the privilege of seeing Mr. Leeds relieve the evident distress of a little child who was lost in the streets of Louisville. He was never too busy to do such an act of kindness and he was a man who naturally made strong friendships. Mr. Leeds was born in Connecticut in 1845 and began railroad service in 1861 as machinist apprentice on the New York & New Haven Railroad. In 1877 he was appointed superintendent of motive power of the Boston & New York Air Line. In 1882 he went to the Louisville & Nashville as master mechanic and in 1889 became superintendent of motive power. He will be greatly missed.

Not over 30 per cent. of the machine tools used in railroad repair shops require special provisions for varying cutting speeds—the usual method of changing speeds by belt and cone pulleys, or by gearing, is sufficient for most requirements. The remaining 70 per cent. of the tools can thus be conveniently driven by constant-speed motors, for which purpose the induction (alternating current) motor is preferable on account of its great simplicity, the absence of commutators or other exposed current collecting devices, and its extensively proven reliability.—L. R. Pomeroy, before the Central Railroad Club.

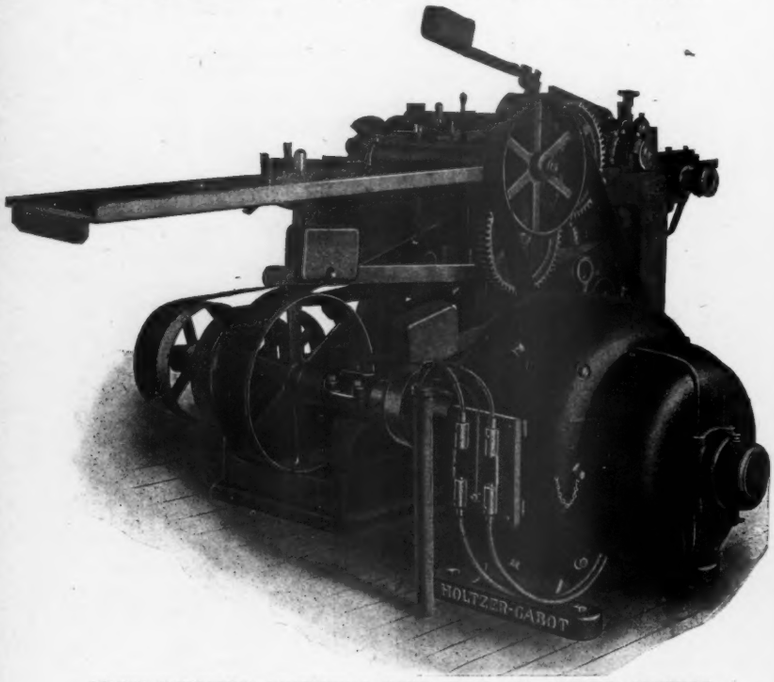
WOODWORKING MACHINERY.

IMPORTANT DEVELOPMENTS IN INDIVIDUAL DRIVING BY ELECTRIC MOTORS.

The principle of driving wood-working machines either individually or in groups by electric motors has come to be regarded as a necessary feature of the equipment of every modern wood-working establishment, whether in a railroad shop or elsewhere. The importance of the electrical system transmission of power is being realized, and during the last few years both builders and users have given the subject special consideration.

As our readers are doubtless aware, the advantages to be gained from the electric power transmission and driving are numerous, but the most important may be treated under the following heads: First, saving of power; second, decreased cost of maintenance; third, increased output, and, fourth, convenience and flexibility.

The saving of power through the direct driving of wood-working tools by electricity is a matter of the highest importance. Tests have brought to light instances where five-sixths of the power developed in the ordinary engine room was dissipated in the shafting and belting, this with every machine running at full load, a condition seldom reached in practice, and the maximum of efficiency of the plant proved to be only 30 per cent. This is an abnormal case, however, and is the exception rather than the rule.



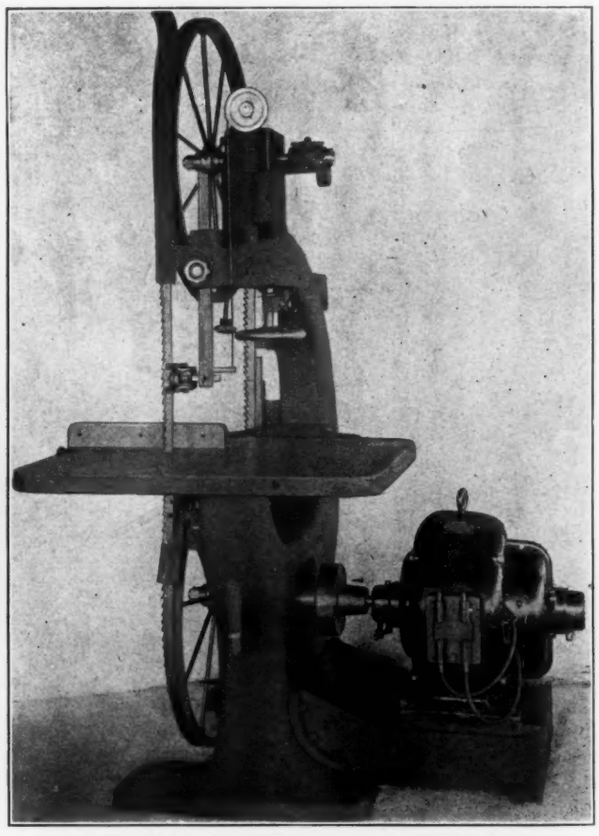
DIRECT-CONNECTED INDIVIDUAL DRIVE UPON AN OUTSIDE MOULDER BUILT BY THE S. A. WOODS MACHINE COMPANY.

The quantity of power required to drive wood-working machinery varies enormously according to the character and quality of the lumber worked, the speed of feed, the depth of cut and more particularly the *condition of the knives, teeth and other cutting edges.* The importance of keeping the cutting edges in good order will be apparent when it is understood that a given amount of work, on either green or dry lumber, may easily require an expenditure of 300 per cent. more power when the knives or cutters are dull than when they are sharp. Again, the power required by the machine itself is very much greater than that required by a metal-working tool of corresponding size, and when this large amount of power is to be transmitted through considerable belting and long runs of shafting, the losses in transmission are great.

As to the decreased cost of maintenance, in eliminating the major portion of shafting and belting, as is the case when electric power is used, a large and unending expense is avoided. With no shafting to lubricate, no belts to renew or repair and no annoyance from loose pulleys, there is little difficulty in keeping machinery running and the men productively employed. With electricity as the motive power, the horse-power required to run a given plant is less than with steam and a considerable amount of money is saved in coal consumption.

There is no question as to the increase of output, as actual returns from plants that are now operated by electricity show that the output has been increased from 10 to 30 per cent.

With respect to convenience and flexibility, no system of belt and shaft drive can possibly compare with electricity. Where formerly it was necessary to place machinery in a certain position relative to the main or auxiliary shafts, now, with the individual motor-drive, the machinery may be disposed according to the needs of the tools, the available floor space, or with reference to the other conditions that may arise, and if it should be necessary to rearrange the tools it can readily be done. By the use of motors, the machines may always be set up where they are most convenient for the work in hand, without regard to the source of power, and, furthermore, any section of the plant can be operated independent of the other. This opportunity for subdivision is exceedingly valuable when, in running overtime or in other emergencies, one department is enabled to work without waste of energy while the remainder of the plant is at rest. As regards the overhead room obtained by the abolition of shafting, it is in many cases necessary to operate the traveling cranes, and these can be used without any difficulty in shops where the system of individually driving the machines by motors is in vogue.



DIRECT-CONNECTED DRIVE ON 36-IN. BAND SAW.—S. A. WOODS MACHINE COMPANY.

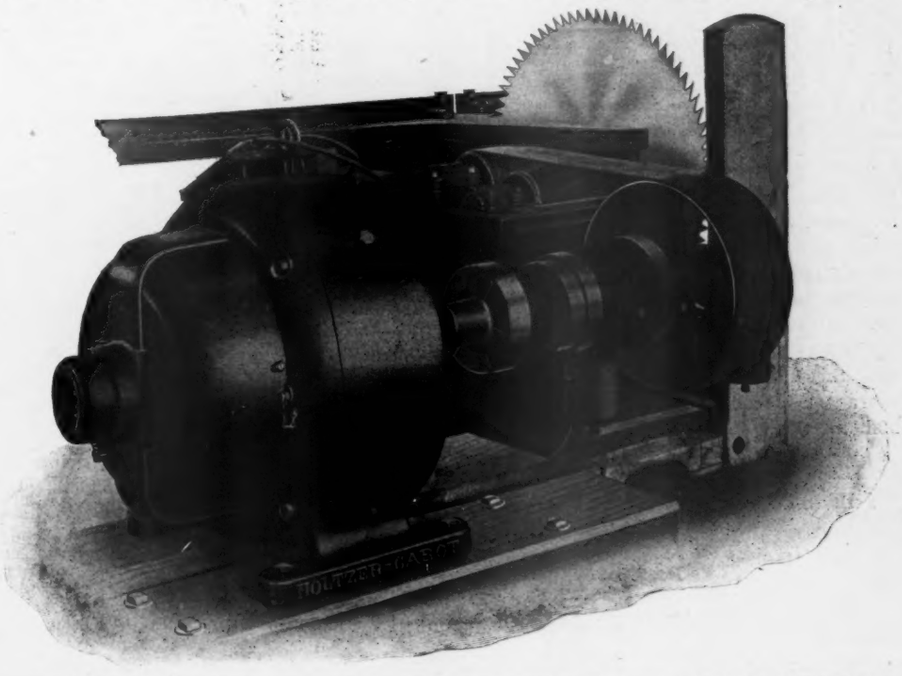
Among the foremost to take up and investigate the question of motor-driving for wood-working tools was the S. A. Woods Machine Company, South Boston, Mass. This company has had this subject under investigation for a long time and has gained valuable experience. As a result they are redesigning a number of their tools to conform to the requirements of the motor drives, and have met with most excellent results, not

only as to the simplicity of the machine equipments but also with respect to the service performed. We are permitted to illustrate herewith a few representative motor drives which have been designed by this company.

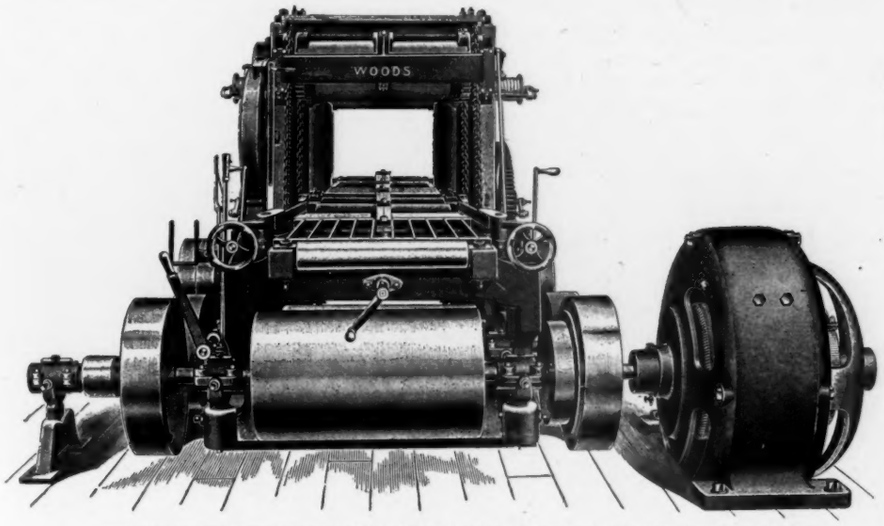
The illustration presented on page 294 represents a direct-connected drive upon a Woods outside moulder. The tool has been designed to bring the main drive shaft in line with the armature shaft and thus avoid blocking up or depressing the motor, which merely rests upon the floor. The motor, which is a 20-h.p. Holtzer-Cabot constant-speed direct-current motor, is coupled to the drive shaft by a shaft coupling. The arrangement of the drive is neat and compact, the important features of the tool being in no way interfered with.

The engraving on page 294 illustrates a 36-in. Woods band-saw arranged for motor driving. The motor, which is in this case also a Holtzer-Cabot constant-speed direct-current motor, is here mounted upon a cast-iron bracket which is bolted to the side of the frame and partly rests upon the floor. This is necessary to raise the motor for alignment of the shafts, the motor being direct-coupled to the lower band-wheel, thus avoiding all belting.

The next engraving on this page illustrates a method of motor mounting and connection that was used for an individual drive upon a Woods railway cut-off saw. The motor was here placed upon blocking to align its shaft for direct-coupling connection; it is arranged at the rear of the tool so as to offer no obstruction to its operation.



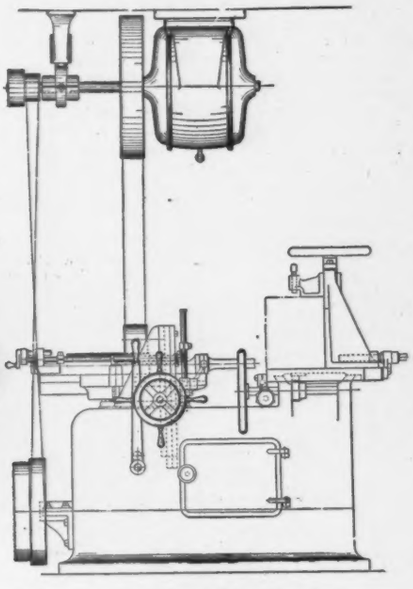
DIRECT-CONNECTED INDIVIDUAL DRIVE UPON A RAILWAY CUT-OFF SAW.—S. A WOODS MACHINE CO.



DIRECT-CONNECTED INDIVIDUAL DRIVE UPON A HEAVY PLANER AND MATCHER. S. A. WOODS MACHINE COMPANY.

An interesting motor drive is illustrated in the engraving presented immediately above this paragraph. It represents a Woods extra heavy planer and matcher, with power hoist, arranged for driving by a 60-h.p. motor. The motor is located upon the floor and is so adjusted as to permit of direct shaft connection, as shown. The service required in a drive of this type is very exacting and severe, and needs a very heavy motor. This arrangement for driving is, however, very compact and accessible.

The engraving at the right shows diagrammatically an arrangement of individual driving which has been applied to a horizontal 1½-in. Woods mortiser. In this case a ceiling motor is used, being belted down to the machine for an increase of speed. This machine, which will mortise from 5-16 to 1½ ins., requires 15 h.p.



BELTED INDIVIDUAL DRIVE UPON A WOODS HORIZONTAL MORTISER.

The S. A. Woods Machine Company state from their experience that the problem of driving wood-working machinery by motors is rather a difficult one, owing to the variable nature of the machines. Consider, for instance, the 15-in. four-head Woods fast-feed planer and matcher, which is largely used by railroads for the production of flooring, sheathing, siding, etc.; this machine was connected to a motor at their works and subjected to a rigid test. The starting load was 28 h.p., but it dropped afterwards, as the machine became warmed up, to 20 h.p. Later a 1-in. board 8 ins. wide was fed through the machine and, with the top and bottom heads removing ¼ in. therefrom, while the board was going through the machine at the rate of 60 ft. per minute, 32 h.p. was required. From this it is to be learned, therefore, that a 15-in. planer and matcher will require from 20 to 35 h.p., according to existing conditions.

This is a fair example of the variation in planers and

matchers generally, and, as stated earlier in this article, the result depends largely upon the condition of the cutting tools, perfect conditions requiring much less power than would ordinarily be estimated.

A large number of the tools built by this company are now being operated by electricity and those most commonly used may be approximately estimated for power as below:

24 and 20-in. heavy timber sizer or car-sill dresser, from	45 to 60 h. p.
8 and 15-in. planer and matcher, from	20 to 35 h. p.
24 and 30-in. planer and matcher, up to	45 h. p.
36 by 6-in. cabinet planer (single surfacer)	10 to 15 h. p.
13 by 6-in. triple column outside moulder	20 h. p.
16-in. self-feed saw table	15 to 25 h. p.
14 by 16-in. automatic railway cut-off saw	15 to 20 h. p.
30 to 42-in. automatic knife grinder	2 h. p.
1½ to 2 sq. in. hollow-chisel mortiser	15 h. p.
5-16 to 1½ sq. in. hollow-chisel mortiser	10 h. p.
Multiple-spindle boring machines require from	6 to 8 h. p.
Automatic car gainers about	15 h. p.

These figures represent the maximum requirements under the usual mill conditions and cover the momentary loads, although, as before stated, with perfect conditions the power could be reduced considerably. We know of cases where some of the machines enumerated above are being operated with motors considerably smaller than we have recommended. This is perhaps due, as we have stated before, to the existing conditions at the various plants. It must be borne in mind that these amounts are estimated from their knowledge of average mill conditions. These builders are prepared to furnish all their machines for direct motor driving.

THE STEAM TURBINE FROM AN OPERATING STANDPOINT.

By F. A. Waldron.

From a paper read before the American Society of Mechanical Engineers.

The steam turbine which this paper will describe is installed at the works of the Yale & Towne Manufacturing Company, Stamford, Conn., and is the first one of its size (outside of those operated by the builders) to be put into practical operation in this country. It is the writer's intention, therefore, to give not only an account of its installation and operation, but also data from the boiler-room to a brake horse-power delivered from the driving pulley of the motor.

After a thorough investigation by the writer, in the early part of 1901, it was decided to install a Westinghouse-Parsons steam turbine, for the following reasons: (1) Floor space, (2) economy, (3) continuous operation of existing plant during installation of the new. The problem was, therefore, to concentrate the largest amount of power in the smallest possible area consistent with economical operation.

The generating outfit consists of a two-phase, 240-volt alternator of 400-kw. capacity (when the turbine was running condensing, and the power factor of the alternator was from 90 to 100 per cent.), 7,200 alternations, running at 3,600 r. p. m., with a separate direct-connected exciter set. The alternator is of the revolving field type, and the surface speed of the field is 22,137 ft. per minute. The weight of the outfit is 33,200 lbs., and it occupies a floor space 19 by 4½ ft. The guaranteed economy was 16½ lbs. of water per electrical horse-power at the switchboard, with 28 ins. of vacuum, 40 degs. Fahr. superheat, and 155 lbs. gauge pressure.

Sixty-four induction motors (with varying loads), ranging from ½ to 40 horse-power, are distributed throughout the works. With the exception of the elevator motors, the entire plant is arranged on the group system. Wherever one or more machines are to be driven, belting or gearing is used, and if room will permit, belting is given the preference.

The turbine end of this machine has received very little attention in the past year, and has required no renewals or repairs to any of its parts; in fact, from an operating standpoint, it is almost foolproof. Occasional longitudinal adjustment, to check the clearance between the blades in the case and the revolving element, is necessary. The wear and tear on other parts of the machine have been practically *nil*, and if the oil is kept in constant circulation and properly cooled, there is no need of a "hot box," and the amount of oil used is extremely small, the consumption of this particular machine being ½ gal. of cylinder oil per week, and from 3 to 5 per cent. of the lubricating oil on the bearings may be said to be wasted. The principal trouble with the steam end is its liability to shut down, when running from three-quarters to full load, because the vacuum is destroyed. This can be prevented if the engineer is on hand, but sometimes he isn't there, and we have had one or two shut-downs in the last year from this cause. I am informed, however, that a device for automatically preventing this is being designed by the makers, and we expect to have it on our second machine.

The electrical end of the machine has given us *all* the trouble—not from the result of electrical design and defect, but from mechanical defects, pure and simple. The field or revolving element is made of four cylindrical forgings, 23⅜ ins. in diameter, aggregating in length about 28 ins. These sections are forced onto a shaft with about 150 tons pressure. Owing to centrifugal force and the heat developed in the field, one of these sections crept on the shaft about ¾ in., the result being that on August 21, 1902, one of the field wires was pulled apart. Repairs were quickly made, and the makers agreed to furnish us a new field, which was placed in position the latter part of December; when, upon starting the machine for the purpose of testing, it immediately (upon attaining full speed, and without any load upon it) flew into a large number of pieces, entirely demolishing the electrical end and badly damaging the steam end. Investigation showed that invisible flaws in the forging were the cause of this accident.

A memorandum has been kept by the author of all of the questions which had been asked him in regard to this installation, and as a matter of record he would like to place the more important ones before the society, in the order of their importance:

Does it fulfill the guaranteed economy? [The tables show that its performance is satisfactory.—Ed.]

Are you satisfied with the continuity of operation? Outside of the breakdown (which was due to defective material, or to causes entirely foreign to the machine), it is entirely satisfactory.

What condensing outfit is necessary? This is a question which each purchaser can best decide for himself. The writer's experience, however, is that the best is none too good, and that for continuous running and high vacuums the dry system, with a two-stage air pump, will probably maintain higher average vacuums than any other system.

Can exhaust steam be used for heating? This turbine has supplied 25,000 sq. ft. of direct radiating surface and 7,500 sq. ft. of blower-stack surface, and maintained a temperature of from 60 to 70 degs. Fahr. in all buildings when generating 520 kw, and with a temperature of 220 degs. Fahr. in the exhaust chamber of the turbine.

What overload will it stand? A 50 per cent. overload has been maintained at full speed for five hours without apparent injury to the machine.

Can it be changed from condensing to non-condensing and vice

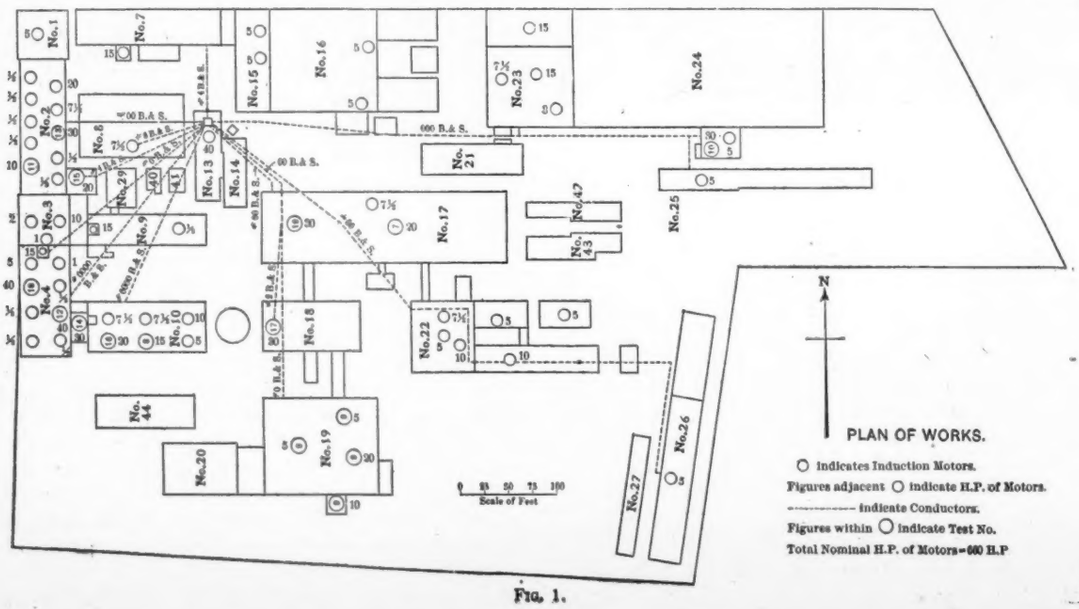

PLAN OF WORKS.
○ Indicates Induction Motors.
Figures adjacent ○ indicate H.P. of Motors.
---------- indicate Conductors.
Figures within ○ indicate Test No.
Total Nominal H.P. of Motors=660 H.P
Scale of Feet
N

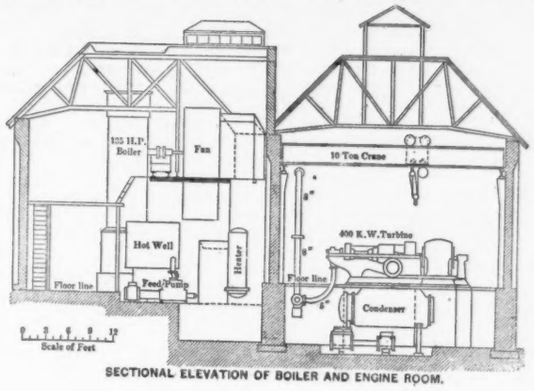
Fig. 1.

versa, when running? This we have done daily, during the heating period, and without difficulty or shut-down.

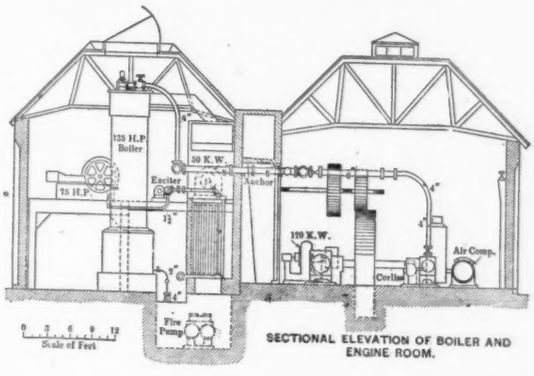
Type of exciter? The exciter should be driven by an independent engine.

Is your confidence in the machine shaken after the trouble you have had with it? The best reply to this is that a second outfit has been ordered.

Cost? Upon the basis of strictly competitive prices, the turbine, ready to run, costs from 10 to 15 per cent. less than the same sized reciprocating engine outfit. The cost of the power-house, per square foot, per kilowatt, would be about 65 per cent. less for a



SECTIONAL ELEVATION OF BOILER AND ENGINE ROOM.



SECTIONAL ELEVATION OF BOILER AND ENGINE ROOM.

chinery when running idle; (c) the total power used by the shafting, machinery and useful work; (d) efficiency of electric transmission.

The tests were made under actual running conditions, the test for each room being continued for one-half day, with regular working load, and readings of the watt meter were taken every two minutes. The mean vibration of the pointer was taken as the true reading. The efficiency of the motors (under their different loads) was taken from the curves furnished by the builders. The analysis of these tests would indicate that, with the turbo-generator driving induction motors, and with an evaporation of 8.707 lbs. of water per pound of coal, a brake horse-power can be delivered from the pulley of the motor for about 2½ lbs. of coal with a turbine of this size running under average economy. (This allows 5 per cent. for banking.) Under the same evaporative conditions the average non-condensing engines distributed through the different rooms in the plant would require 7.5 lbs. of coal per brake horse-power at the fly-wheel, or three times that quantity required for the electrical drive.

In conclusion, the results obtained from this outfit may not be any higher than many obtained by direct-connected sets of the same size running under maximum economical conditions. Assuming, however, that they are the same, the advantages of initial investment, constant economy and the possible extension of the plant with the turbo-generator outfit, are of sufficient importance to warrant the installation. The strongest appeal, however, that the turbo-generator makes to the business man or the engineer is its inherent commercial efficiency. By this I mean that its efficiency is unchanged week in and week out, year in and year out. Leaky pistons or valves, lack of alignment of slides and bearings, keying up, and, above all, lubrication, all of which exist in the reciprocating engine, are eliminated in the turbine.

[EDITOR'S NOTE.—This is an important and excellent paper. It presents illustrations and records of the performance, including boilers, turbines, generators and motors. We reproduce the motor tests, and recommend the reader to secure a complete copy of the paper.]

ALTERNATING CURRENT MOTORS FOR VARIABLE SPEED.

A Paper Read Before the American Society of Mechanical Engineers.

BY W. I. SLICHTER.

The impression is very general that a variable speed cannot be obtained with an alternating current motor, and that if an alternating current plant is to be installed, the idea of obtaining a variable speed drive of any of the tools must be abandoned. This is not so, and the object of this paper is to show the possibilities of this type of motor and to point out its limitations. But it must be understood in the first place that it is not claimed for the alternating current motor that it can compete with the direct cur-

TABULATION OF MOTOR TESTS.

NUMBER OF TEST.	DATA.	Location. Building.	Location. Room.	Location. Kind of work.	Conductor. Size B. & S. gauge.	Conductor. Length of line per Phase in feet.	Energy at switchboard A. K. W.	Energy at switchboard A. H. P.	Average Motor Load. Input B. K. W.	Average Motor Load. Input B. H. P.	Average Motor Load. Output C. K. W.	Average Motor Load. Output C. H. P.	Nominal Rating of Motor in H. P.	Transmission Losses. Electrical. Line loss D=A−B. K. W.	Transmission Losses. Electrical. Line loss D=A−B. H. P.	Transmission Losses. Electrical. Motor loss E=B−C. K. W.	Transmission Losses. Electrical. Motor loss E=B−C. H. P.	Transmission Losses. Mechanical. Shafting F. K. W.	Transmission Losses. Mechanical. Shafting F. H. P.	Transmission Losses. Mechanical. Shafting and Machines Idle, G. K. W.	Transmission Losses. Mechanical. Shafting and Machines Idle, G. H. P.	Efficiencies. % Line (e) = B/A	Efficiencies. % Motor (Commercial) (b) = C/B	Efficiencies. % Electrical* (c) = C/A	Water rate per hour at Motor Pulley. Per K. W.	Water rate per hour at Motor Pulley. Per H. P.	Coal rate per hour at Motor Pulley. Per K. W.	Coal rate per hour at Motor Pulley. Per H. P.	Combustible rate per hour at Motor Pulley. Per K. W.	Combustible rate per hour at Motor Pulley. Per H. P.	Horse-power required per foot of shafting.
	7	17	Rod shop	Automatic screw machinery	No. 00	250	34.4	46.1	33.2	44.5	26.85	36.	27.5	1.2	1.6	6.35	8.5	12.9	17.3	21.6	29.	96.3	81.	78.	28.6	21.3	3.28	2.45	2.72	2.03	.029
	8	10	105	Gen'l machining.	" 4	300																										
					" 0000	530	13.35	17.9	13.	17.43	11.05	14.8	15.	.35	.47	1.95	2.6	5.6	7.5	16.4	22.	97.5	85.	82.8	27	20.2	3.09	2.31	2.57	1.92	.029
					" 6	150																										
	9	19	Cabinet lock shop	Gen'l machining, polish'g & buff'g	" 00	250	36.	48.3	34.5	46.3	28.5	38.2	40.	1.5	2.	6.	8.1	.....	.....	23.5	31.6	95.8	82.5	79.	28.3	21.1	3.24	2.42	2.68	2.00	.041
					" 0	700																										
	10	34	Iron Foundry	Cupola blower & heating system.	" 000	1,400	31.2	41 8	30.	40.2	24.85	33.3	30.	.8	1.07	5.15	6.9	.....	.....	2.4	3.22	96.2	83.	80.	27.9	20.8	3.2	2.39	3.66	1.96	
	11	2	35	Plating dynamos and exciter	" 00	390	5.14	6.89	5.	6.7	4.05	5.43	10.	.14	.19	.95	1.27	.....	.....	.93	1.25	97.3	81.	79.	28.3	21.1	3.24	3.42	2.68	2.00	
					" 6	270																										
	12	4	44	Polishing and buffing	" 0000	500	33.1	44.4	32.5	43.6	28.2	37.8	40.	.6	.8	4.3	5.8	21.1	28.3	22.7	30.5	98.2	87.	85.2	26.2	19.5	3.01	2.24	2.49	1.86	.091
					" 0	130																										
	13	2	24	Polishing and buffing	" 00	390	27.2	36.4	26.5	35.5	22.55	30.2	30.	.7	.94	3 95	5.3	12.3	16.5	17.9	24.	97.6	85.	83.	26.8	20	3.08	2.3	2.56	1.91	.063
					" 2	100																										
	14	4	44	Ventilating system	" 0000	400	26.42	35.4	25.7	34.4	20.7	27.7	30.	.72	.96	5.	6.7	.....	.....	.....	.....	97.5	80.5	78.4	28.5	21.3	3.27	2.44	2.71	2.02	
					" 2	200																										
	15	2	24	Ventilating system	" 4	350	27.2	36.56	26.56	35.7	21.36	28.7	20.	.64	.86	5.2	7.	.....	.....	.....	.....	97.7	80.5	78.7	28.4	21.2	3.28	2.43	2.7	2.02	
					" 0000	520																										
	16	10	101	Heating system	" 4	80	25.8	34.7	24.4	32.8	19.9	26.75	20.	1.4	1.9	4.5	6.05	.....	.....	.....	.....	94.8	81.5	77.2	28.9	21.6	3.39	2.47	2.75	2.05	
					" 8	240																										
	17	18	Smith shop	Drop forging	" 00	250	18.47	24.8	18.1	24.3	15.65	21.	30.	.37	.5	2.45	3.3	.....	.....	15.	20.1	97.6	86.5	84.5	26.4	19.7	3.03	2.26	2.52	1.88	
					" 0	100																										
					" 2	300																										
	18	4	45	Plating dynamos	" 0000	500	23.3	29.9	22.	29.5	19.	25.5	40.	.3	.4	3.	4.	.....	...	5.6	7.5	98.6	86.5	85.2	26.2	19.5	3.01	2.24	2.49	1.86	
					" 0	140																										
	19	17	Tool, mach. & press shop.	Tool making and press work	" 00	310	36.	48.25	35.6	47.7	28.8	38.6	30.	.4	.55	6.8	9.1	14.9	20.	33.5	45.	98.5	81.	80.	27.9	20.8	3.2	2.39	2.66	1.98	.026
																								Ave...	27.65	20.62	3.17	2 37	2.63	1.96	

* Ratio of energy delivered at motor pulley to energy at switchboard.

turbo-generator outfit than for a reciprocating engine of the same power and economy. The cost of foundations is taken into account in the cost of the engine and turbine. The cost of piping is not included in either case, excepting the piping between the throttle and the condenser.

Is the vibration excessive? The author considers that, unless it is possible to balance a lead pencil on the outboard bearing and allow it to remain there for a minute, the machine is vibrating more than it should; and while there are no foundation bolts to hold the machine down, there has been no tendency for it to creep on its foundations.

The principal points brought out by the tests are: (a) Difference in frictional losses, depending on speed and arrangements of shafting in the different rooms; (b) the power utilized by the ma-

rent type where continual variations of speed throughout a wide range are required, as the latter motor is usually superior in efficiency under these conditions.

Let us assume, then, that the problem to be solved is a case where an alternating current plant is desirable for general reasons, such as distance of transmission or availability of power, and that a considerable amount of the power is used in constant speed work, but a certain portion of the work requires a variable speed. What is the most appropriate and most efficient method of obtaining the variable speed?

The speed of an alternating current motor may be controlled in a number of ways:

(a) By varying the potential applied to the primary of a motor having a suitable resistance in the secondary; (b) by varying the

resistance in the secondary circuit; (c) by changing the connections of the primary in a manner to change the number of poles; (d) by varying the frequency of the applied voltage.

For the benefit of those not familiar with the polyphase induction motor, a general view of its characteristics may be desirable.

These characteristics are very similar to those of the continuous current shunt motor—that is, at a constant impressed voltage and frequency the speed tends to be constant, and a considerable change in load will not cause an appreciable change in speed. As the load increases, the speed drops gradually to a critical point, usually about 15 to 20 per cent. below the normal value, and then the motor breaks down completely if the load is any further increased. The same action occurs exactly if the load is kept constant and the voltage is decreased. But if the frequency of alternation of the impressed voltage is decreased, the speed will decrease in exactly the same proportion. That is, for a given frequency and a given number of poles in the motor, the speed is practically fixed and independent of all other effects. The one exception to this last rule is the effect of the resistance (or losses) in the secondary (usually the rotating) member.

The drop in speed from the synchronous value is directly proportional to these losses. Thus, by increasing the resistance of this circuit, any desired speed may be obtained at the expense of these losses. With the increased resistance, the speed at which the motor breaks down may be reduced to a very low value, even to zero speed. Thus, by reducing the voltage applied to the motor for a given torque, the effect is produced of overloading it, and the speed drops. These characteristics are equally true for the 2-phase or 3-phase motor, of course, as the two motors are practically identical in their construction.

In this connection it should be remembered that a variation of an alternating voltage may be obtained by means of a reactance or compensator with a very small loss of energy, whereas with a continuous voltage the loss of energy is usually proportional to the variation in voltage.

Potential Control.—In this a suitable reactance or "compensator" reduces the line voltage to the fractional value desired. In this reduction the energy lost is only about 5 per cent. of the amount transformed.

The induction motor should have a very large resistance in the secondary, which is preferably of the squirrel cage type. This resistance gives the motor a speed characteristic such that its full load speed is some 10 per cent. less than that of a normal motor, and as the load is increased, the speed will fall to about 30 per cent. of this value without the motor "breaking down" or falling out of step, which in the normal motor usually takes place at about 80 per cent. of the full load speed.

Such a motor would have the following characteristics, assuming its synchronous speed as 1.00, and the voltage applied as 100. (This is based on a 50-h.p., 40-cycle motor, at 800 revolutions per minute, as an instance.)

For constant full load (50-h.p.) torque at various speeds:

	Speed.	Volts.	Efficiency.	Losses, Motor.	K.W. Comp.
Full load speed	.89	100	81	8.8 K.W.	0.0 K.W.
Three-quarter load speed	.67	66	59	18.5 K.W.	1.0 K.W.
One-half load speed	.45	57	37	32.0 K.W.	2.0 K.W.
One-quarter load speed	.22	56	17	45.7 K.W.	3.5 K.W.
Normal motor (full speed)	.98	100	88	5.0 K.W.	0.0 K.W.

From this we see the principal and worst characteristic of this scheme. The increased losses in the motor (thus increased heating) with the decreased speed. This means that the motor must be larger than normal.

Rheostat Control.—In this scheme the secondary or rotor must have a definite winding (as opposed to the squirrel cage, which is cheaper) with slip rings and brushes to lead out the current. The friction and resistance losses due to these brushes decrease the efficiency of the motor somewhat. The secondary is usually wound for a higher voltage and less current than in the standard or normal motor, to minimize these losses. The action of this method is based on the principle that, in an induction motor, the drop in speed for any given torque is proportional to the resistance of the secondary circuit.

This scheme would show the following characteristics for the same motor as before at 50-h.p. torque, constant:

	Speed.	Volts.	Eff.	Losses, Motor.	Rheo.
Full load speed	.96	100	86	5 K.W.	0.0 K.W.
Three-quarter load speed	.72	100	65	5 K.W.	9.0 K.W.
One-half load speed	.48	100	43	5 K.W.	18.5 K.W.
One-quarter load speed	.24	100	22	5 K.W.	28.0 K.W.
Normal motor (full)	.98	100	88	5 K.W.	0.0 K.W.

As will be seen, this method gives a higher efficiency throughout, but particularly excels the previous method in having so much smaller losses in the motor itself, thus permitting of a smaller design and less danger of damage. The losses are concentrated in a rheostat, which is a cheaper piece of apparatus and less liable to damage, being of iron and asbestos usually, instead of high grade insulating materials, as in the motor proper.

Changeable Poles.—By using a pitch of winding which is commensurable with two numbers of poles, we may build a motor which will operate with either 4 or 8, 6 or 12, etc., poles, by a slight change of the connections. Or by a more intricate arrangement of windings a change from 4 to 6, 6 to 8, etc., may be made. In this arrangement it is necessary to use a squirrel cage armature, since it is suitable for any number of poles, and the pitch of the primary coils has to be made some compromise value between the normal pitch of the two combinations, so it is usually not the best or most effective pitch for either number of poles. Therefore the constants of this motor should not be expected to be as good as those of the standard motor. Of course such a motor operates advantageously only at two speeds corresponding to the synchronous speeds of the two arrangements. Thus, a 12 and 6-pole motor at 40 cycles would operate at either 400 or 800 revolutions respectively. If a wider range is desired, the potential control scheme first mentioned may be combined with it.

For a motor operating at full and half speeds, say with 6 and 12 poles for 800 and 400 revolutions, we would have:

	Volts.	Eff.	Losses.
Full speed, 50 h.p.	100	86	5.8
Half speed, 25 h.p.	100	74	6.6

Thus, for full load torque at half speed we get an efficiency almost double that obtained with the other methods, but what losses there are are in the motor itself, as in the first case. The losses are about the same in the two cases, the speed thus the ventilation being half in one case, the heating is greater at the lower speed.

Variable Frequency.—Every induction motor tends to run at synchronous speed—that is, at a speed equal to $\frac{60 \times \text{frequency.}}{\text{Poles}}$

Thus, if a different frequency is impressed on the motor, it will run at a different speed. Some installations have been made where two or three alternating current generators are used to obtain different frequencies, and these circuits are carried around the shops by various sets of lines (usually three in each set) and the motor connected to the lines giving the frequency and speed desired. For normal losses in the iron the voltage must vary with the frequency. Thus for full and half speed we have:

	Volts.	Eff.	Losses.
Full speed, 50 h.p.	100	88	5
Half speed, 25 h.p.	50	87	2.8

Generators have been built having two stationary armatures in the same frame and two revolving fields, with a different number of poles on the same shaft to give the multiple frequency desired. An application of this principle, which is very pretty theoretically, is that of a very small variable speed induction motor (whose losses are negligible) which drives a commutator feeding the primary of the load machine; by a suitable control of the little motor any desired frequency may be supplied to the load machine from zero to full value, thus it may be started and run at any desired speed. A variation of this is to attach the commutator to the shaft of the load machine and the brushes to the shaft of the controlling motor, thus when the load machine is standing still the brushes revolve at almost full speed on the commutator, and a very low frequency is obtained in the commutated circuit. As the load machine speeds up, the difference in the speeds of the commutator and the brushes decreases, and hence the frequency increases until that time when the commutator and brushes are revolving together at the same speed when there is no commutation and the load machine receives full frequency.

SUMMARY.

From these descriptions it will be seen that the changeable pole and variable frequency methods are the most efficient, but do not permit of a variation through a wide range of speed. The rheostatic control is the simplest and easiest of control, giving a range from standstill to full speed, but is not as efficient as the first two, although more efficient than potential control. The last mentioned has the disadvantages of low efficiency and considerably increased heating in the motor itself, and is also unstable at low speeds, say below one-third speed. That is, a small variation in torque or a smaller variation in voltage will cause a considerable variation in speed.

The potential control is used where moderate variations in speed are wanted, not reaching to less than half speed for instance, and where the load is intermittent, not giving the motor a chance to get too hot. Its great disadvantage is the amount of current it takes at starting, which causes considerable disturbance in the supply circuit, flickering of lights, etc., due to the drop in voltage. The motor used is a cheaper one to build (for the same size) than the others, but if anything like continuous running is desired, the motor must be larger, thus much of this advantage is lost.

One advantage of this motor is that it may be totally enclosed for use in powder mills, oil refineries or where much dust or corrosive vapor is encountered, as it may be controlled from a distance without increasing the number of wires.

The rheostatic method is particularly adapted where frequent starting and low speeds are required, as it causes no unusual drain on the supply system when starting. Thus it is used for hoists, elevators, etc.

The changeable pole system has the same disadvantages in starting as the potential control. For long-continued running at only two different speeds it is excellent, and has constants comparable with those of a continuous current motor.

To vary the frequency of alternation for the motor requires an increased investment in generating station or auxiliary apparatus and line copper, and the greater the number of speeds desired, the greater this complication; but in its action and economy it is equal to any.

One point which is important to bring out is that with the changeable pole and changeable frequency systems the motor will not vary appreciably from the set speed for changes of load, while with either potential or rheostatic control, a change of load will cause an appreciable variation from the desired speed, requiring a readjustment of the potential or resistance to bring the speed to the desired value again.

An excellent illustration of the reliability of the induction motor was recently presented in a large plant using the 3-phase alternating-current system of power distribution. One of their induction motors is located at the foot of a fine-coal storage bin and works constantly in an atmosphere charged with coal dust. The motor has frequently worked without interruption while almost entirely embedded in accumulations of fine coal, and when it is cleaned out periodically a large quantity of coal is always taken out of it. It works constantly and with no attention except occasional greasing. The motor in question is one of the well-known type "C" 3-phase motors made by the Westinghouse Company.

TRACTION INCREASER AND WEIGHTS ON DRIVERS.

NEW YORK CENTRAL 4-4-2 TYPE LOCOMOTIVE.

The actual weights on drivers and trucks of the 4-4-0 type passenger locomotive of the New York Central have been obtained in order to answer an inquiry for the exact figures. This engine was illustrated and described in this journal in February, 1901, page 35. The figures are as follows:

	Lbs.
Weight on drivers, working order, normal	94,800
Weight on drivers, working order, with traction increaser in service	104,800
Weight on forward truck, working order, normal	42,600
Weight on forward truck, working order, with traction increaser in service	37,000
Weight on rear truck, working order, normal	38,600
Weight on rear truck, working order, with traction increaser in service	34,200
Total weight of engine, working order	176,000
Weight of tender, loaded	114,000
Weight of tender, empty	50,800

"The worst fault I have to find in most all tools is that they are short of power. As a rule, the belt speed is too slow, and the gearing is too weak. If you take almost any tool and adapt it for electric driving, where there is no slip of the belt, you will find that it is only a question of time before the gearing begins to give trouble and ultimately breaks down. Almost every tool I have bought is defective in this detail, and could have easily been improved with a little forethought and at very little expense. In this respect my experience has been shared by most of my friends. A few days ago I was looking through one of the most up-to-date shops in this district, and the same lamentation was there, viz., want of power. The tools would not do what they were led to expect, and all sorts of excuses were made by their makers.

"All large machines that have heavy parts that require to be moved should be fitted with a power motion to such parts. Except in a few cases, the quick 'hand transverse' should be done away with, and quick 'power transverse' should be substituted. All radial drills should have a proper power motion for raising and lowering the arm—something a little better and quicker than putting on and taking off a belt."—A Large User of Machine Tools.

The annoyance of troublesome vibrations set up by a steam engine resting on a concrete foundation resting on a thick bed of clay, with rock underlying, were suppressed in the following manner, according to the *Iron Age:* The engine was removed and shafts 4 ft. in diameter were sunk into the subsoil for a distance of 30 or 40 ft. At the bottom of the shafts enlargements were made and concrete foundations put in. Cast iron pipes, 30 ins. in diameter, in 12-ft. lengths, were reared on these foundations to the under side of the engine bed. The pipes were then filled solid inside with Portland cement concrete, and sand packed around the outside of the pipes, filling up the shafts. The engine bed was relocated and wholly supported in this way, isolated from the surface soil.

The Gisholt Machine Company, Madison, Wis., has recently amended its articles of incorporation, increasing its capital to $750,000. This company has confined itself almost exclusively to the manufacture of the now well-known "Gisholt" lathe. These tools are made in several varieties and sizes, and the line is being constantly extended. Increased demands have necessitated a considerable addition to the manufacturing facilities, both in buildings and equipment. These will double the former capacity. A large portion of the new additions will be used in producing the "Gisholt" lathe, and part will be devoted to the manufacture of other types of machine tools, such as boring mills, etc. These new machines, however, will not be undertaken until the completion of the buildings. Among other new facilities, contracts have been let for a large new foundry with the best up-to-date equipment. Fireproof construction will be employed in all of the buildings.

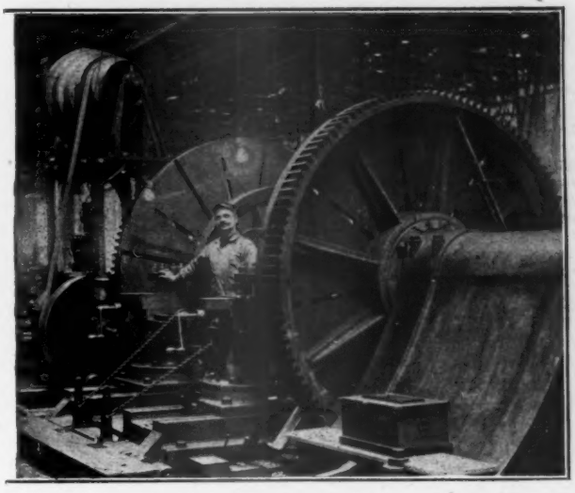
100-INCH DRIVING-WHEEL LATHE.

WEST MILWAUKEE SHOPS.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

In referring to the large motor-driven Bement-Miles wheel lathe at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Railway on page 195 of our May, 1903, issue, we were inadvertently in error in stating that the motor used for the drive was a General Electric motor; we take pleasure in stating that this motor was built by the Milwaukee Electric Company, Milwaukee, Wis.

We are informed that this driving-wheel lathe, the photograph of which is reproduced herewith for reference, has made a remarkable record in operation. This tool is one of the heaviest driving-wheel lathes ever built, having a capacity for turning tires up to 100 ins. in diameter. The size of the lathe may best be judged from the fact that it weighs, exclusive of the motor, 112,000 lbs. The motor is one of the standard 20-h.p. direct-current machines built by the Milwaukee Electric Company. It is equipped for a 30 per cent. speed



100-IN. DRIVING-WHEEL LATHE.
CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

range by field control, the normal field speed being 650 revolutions per minute and the maximum 850 revolutions per minute.

The interesting test was made upon this lathe last spring. A pair of 84-in. tires were turned simultaneously with an average depth of cut at each tool of 5-16 in. and a feed of 3-16 in. The cutting speed was 18½ ft. per minute. The average horse-power required at the motor was 16½ h.p., but when cutting through hard spots on the tires the power required jumped up as high as 22½. Under this heavy duty the time required for the work was 63 minutes.

It is to be noted that the power required during this performance was very high, as the majority of motor-driven wheel lathes in use in this country are equipped with 7½-h.p. motors. We are pleased to learn also that the method of driving through cone pulleys, arranged with close centers and no adjustment for tightening the belt, is proving very satisfactory. We are indebted to Mr. F. M. Cox, formerly master mechanic of the above-mentioned shops and now superintendent of the Milwaukee Electric Company, for this correction and interesting information.

Mr. E. H. Symington, formerly connected with the T. H. Symington Company, of Baltimore, is now associated with the Railway Appliances Company, of Chicago, as manager of the Symington journal-box and dust-guard, the Railway Appliances Company being agents for the Chicago territory.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
J. S. BONSALL, Business Manager.
140 NASSAU STREET.....NEW YORK

G. M. BASFORD, Editor.
C. W. OBERT, Associate Editor.

AUGUST, 1903.

Subscription.—$2.00 *a year for the United States and Canada;* $2.50 *a year to Foreign Countries embraced in the Universal Postal Union.*
Remit by Express Money Order, Draft or Post Office Order.
Subscriptions for this paper will be received and copies kept for sale by the
Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
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Century News Co., 6 Third St. S., Minneapolis, Minn.
Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C., London, England.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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THE METRIC SYSTEM.

At the conventions of the Master Mechanics' and Master Car Builders' associations the question of the metric system was handled promptly and decisively. There is no possible excuse for prolonged discussion on this subject at this time. Those who do not now know how they stand will never know and a lot of time has been lost by prolonged debates. It was well to vote and then pass on to other matters. The vote was almost unanimous in both associations and adverse to the proposed legislation looking toward the compulsory use of the system in the departments of the Government.

The metric system must eventually stand upon its merits. If it is good it will come into universal use. If it is not good it will not do so. Thus far experience seems to show that no existing system is sufficiently perfect to warrant universal adoption.

THREE CONVENTIONS AT SARATOGA.

Master Mechanics' Association.

With 97 new members, a new scholarship at the disposal of the association, a fund for scientific testing inaugurated by the Jerome Wheelock legacy and the locomotive tests at the St. Louis Exposition in prospect, this convention may be said to be an epoch-making one. Besides these important factors, the convention itself was most successful. The younger men are taking hold vigorously and the discussions took a new form. There was comparatively little of the old "experience meeting" about them, and often fundamental principles were touched, which means much to the future of the organization. For example, the discussion of the new tool steels developed the fact that an improvement of this kind induces others. The study of cuts, feeds and speeds brought out the far more important factor of time spent in getting ready to take cuts in the machines, a field for a vast amount of far-reaching improvement.

In the subject of electric driving of shops, two new principles were stated, and it is believed that they have not been stated before and that both are true, viz., that an improvement of 2½ per cent. in output will pay the cost of variable speeds on motor-driven tools and that if machine tools are furnished ready for motor attachment without additional cost it will cost no more for individual driving of tools costing $250 or more than for belting and countershafting. These statements will give food for thought to machine-tool builders, electric experts and shop managers. If not controverted they will exert a powerful influence on future practice.

Locomotive failures due to leaky tubes was unquestionably the most important subject concerning locomotive operation. This discussion was cut too short for lack of time, but the matter is in the hands of a strong committee empowered to secure data for next year. Mr. O. H. Reynolds called attention to the degree to which present practice has departed from the ideas of boiler proportions held by such men as D. K. Clark, and it is time the locomotive boiler should be studied and developed for the severe work it is called upon to perform. The discussion of this subject promises much for the future of American locomotives. It is necessary in some way to secure reserve boiler power to avoid working boilers "to death" in ordinary service. Something must be done to change the condition which makes it necessary for round houses to be full of boiler makers the country over.

An opportunity for which the railroad world has been waiting is offered by the decision of the Pennsylvania Railroad to include in its exhibit at the St. Louis Exposition the new locomotive testing plant. Under the direction of Mr. Willard A. Smith, chief of the transportation exhibits, the plant will be amply provided for and it will be kept busy with tests of American and foreign locomotives for the seven months of the exposition. The exhibit will be under the efficient charge of Mr. F. D. Casanave, formerly general superintendent of motive power of this road. The plans and even construction of the plant are now under way. The American Society of Mechanical Engineers will be represented in the tests by Prof. Goss, Mr. E. M. Herr and J. E. Sague. The Master Mechanics' Association by Messrs. F. H. Clark, H. H. Vaughan and C. H. Quereau. It is fitting that Prof. Goss should be permanent chairman of this joint committee, as he was the first to show the locomotive testing plant to be a success.

An additional scholarship placed at the disposal of the association was a feature of this convention. Messrs. Jos. T. Ryerson & Son, Chicago, have set a worthy example by providing a fund from which $600 will be available for four years to defray the expenses of a student at one of the technical schools. The candidate must be a graduate of a high school, an employee in a shop under the jurisdiction of a member of the Master Mechanics' Association, and he must be in good health. There is no restriction as to schools selected, and while there is no legal obligation to repay the money, it is to be understood as "a debt of honor, to be returned if circumstances permit." The donors express the hope that this may become the nucleus of a large fund to be made up of contributions from those who have been benefited. This generous action is worthy of the highest commendation.

This year and last have brought a new significance to the exhibits at the conventions. The exhibits reflect increasing efforts to follow the needs of the railroads and produce that which will meet the requirements. This has brought satisfactory response from the railroad men. The cursory examinations of former years do not now suffice. The larger roads now send a number of representatives. This is also noticed in connection with the large systems of roads. These men meet by appointment and make a thorough study of the exhibits, assembling afterwards for a conference to compare notes and review impressions. The writer was invited to

join three such groups and is sure that nothing on the grounds was missed. Until last year this sort of thing was not so noticeable. This tendency is encouraging. It is apparent that the convention exhibits bear a closer relation to the work of both of the associations than ever before, and that they are becoming increasingly important.

The sentiment generally expressed at Saratoga favors St. Louis as the place for the next convention. Already guarantees have been made for satisfactory accommodations and the exposition, with its unusual facilities for studying transportation exhibits, together with the locomotive testing plant, render it most desirable to hold the conventions there. It is to be hoped, however, that arrangements may be made to hold them in May or early in June and before the advent of the hottest weather; also that no pains will be spared to secure a suitable hall for the conventions and avoid the serious effect of the unsatisfactory hall this year at Saratoga.

Master Car Builders' Association.

While all three conventions were hurried by long programmes, this fault was most noticeable in this one. A number of topical discussions were left out, and their value to a large extent was lost. It would be a good plan to print the presentations of topical subjects for distribution with the advance copies of papers and reports. Their effect would not then be lost in case they are crowded out of the sessions.

This leads to a remark that the only discussion of steel cars this year was a topical one, and yet this is one of the most important problems before the association. A rather unfair impression may be derived from the discussion this year. Steel cars are not perfect, but several speakers expressed themselves in such a way as to give the impression that they are far from satisfactory. This is not the case, and those who use the largest number of steel cars said nothing of this kind. It is not claimed that all steel cars are satisfactory, but that careful design results in the best equipment ever built when steel or composite construction is used will not be questioned. An example in point is the remarkable series of composite cars on the Norfolk & Western, which has often been referred to in these columns. It must be remembered that while the earlier designs of steel cars were made by railroads, at present this matter is almost entirely in the hands of the manufacturers. That this subject is now treated only in a topical discussion is rather a reflection on the association. In fact, the M. C. B. Association, as an organization, cannot be said to have kept in the closest touch with steel cars. It may have been better to leave the problems to the manufacturers. The fact is that this has been the rule.

Just now an opportunity is presented for good work in steel frame design in connection with the standard car, and this is a problem which the association only can solve. Whatever individual opinions of the business question involved in steel frame construction may be, it must be admitted that on many roads it is justified and that a large number of such cars will be built. Therefore it seems necessary to provide for both wooden and steel-frame cars in the preparation of standard designs. Progress on the standard car must necessarily be made thoroughly and carefully, but if the fact is appreciated that this is the greatest opportunity of the association to-day the utmost possible progress will be made.

While many other subjects might be commented upon, only one more may be mentioned here—the movement toward 2-in. train lines for heating passenger cars. This marks a radical reconstruction of practice in steam heating of passenger trains and it will undoubtedly lead to the careful overhauling which has become necessary through the rapid advances in train operation, with which heating systems have not kept up. The manufacturers of this equipment are somewhat in advance of the railroads and the discussion this year promises a renewal of attention which has become necessary.

Space permits but a brief reference to the fact that the very large attendance and spirited interest in the subjects combined to make this a most successful convention.

American Society of Mechanical Engineers.

That the recent Saratoga meeting was successful was apparent to everyone in attendance. Arrangements for entertainment and excursions were admirable, the only regrettable feature being a hall near a busy railroad track and with poor acoustic properties. The programme was too long for adequate discussion of some papers, but if the members were prepared to present discussions in concise and time-saving form there would have been time for all.

The event of the meeting was the reception of an entirely new constitution, which had been prepared by a special committee, and was ordered submitted to letter ballot practically without discussion and without dissent. This was a remarkable achievement. The secret lay in the report itself, for which great credit is due Mr. C. W. Hunt, chairman of the committee, and also in the fact that every member had been given an opportunity to express to the committee his views of the preliminary draft before its final presentation.

At this meeting the results of a letter ballot to ascertain the views of the members on the subject of the metric system was announced. A total of 514 members voted, of whom 3 to 1 were opposed to the metric system and to any legislation in favor of its adoption. It is to be hoped that this action has effectually buried the metric system as far as this organization is concerned.

Discussion upon the paper by Mr. Blood on the subject of train resistance formulæ was not at all satisfactory. The author made clear the necessity for better formulæ, but the fact that a dynamometer car is really required for any important work was not clearly brought out.

Among the many subjects before this meeting, that of shop management was of transcendent importance. It was treated in three separate papers—"The Machine Shop Problem," by Charles Day; "A Graphical Daily Balance," by H. L. Gantt, and "Shop Management," by F. W. Taylor. The first of these stood for proper organization, suitable equipment and good management. The second made a strong point for exact knowledge of the condition of the work in shops and a record which would enable the management to know exactly what was on time and what delayed, and to know this every day. The third took the ground of large wages for large output. This paper by Mr. Taylor is a monumental work and one which is thoroughly worthy of study. Its length forbids abstracting and the reader is recommended to procure the paper itself from F. R. Hutton, secretary of the society, 12 West Thirty-first street, New York. This paper is a description of the methods of Mr. Taylor, and it discusses the problem of the payment for labor in a masterly way. Mr. Taylor goes into interesting details as to his elaborate methods of "time study," which is the foundation of his work. He also discusses the inducements which must be offered in order to lead men to do their best, and quotes results. Mr. Taylor writes and speaks of his methods with the force of personal conviction, and besides his actual accomplishments he will undoubtedly lead many to follow more systematic methods of studying the elements of work without which correct prices cannot be established. The discussion drifted into the subject of trades unionism, which is a most important factor in shop management. As a whole, this discussion was one of the most important and valuable ever had in the society. It brought out the fact that many bright men are earnestly attempting to solve the problem of shop management.

Of the remaining subjects, the most noteworthy was that of the steam turbine as described by Mr. F. A. Waldron. This paper will be presented in abstract. It shows conclusively that the steam turbine has literally leaped into a position before the mechanical world which entitles it to complete confidence as a satisfactory steam engine. While susceptible of improvement, it is now satisfactory and is likely to at once take a very prominent place for work to which it is adapted.

Lack of space prevents further comment on this very successful meeting.

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

REPORT BY PROFESSOR GOSS.

XVIII.

Continued from Page 241.

43. *A Tabulated Statement of Stack Diameters.*—Experience having shown that equations, however simple in form, are less convenient than tabulated results derived therefrom, it has seemed best to present herewith the conclusions of the stack tests in tabulated form. In preparing the tables it has seemed wise to cover a range of dimensions embraced by wide limits. For this reason the minimum diameter of front-end is 30 ins. and the maximum 90 ins., and the stack heights are made to vary from 16 to 66 ins.

It should be evident to any one who has followed the discussions of the preceding paragraphs that the values given in the table have not in all cases been determined by experiments, but are those derived from the formulae based on the results of experiments as presented in the preceding article (Paragraph 41.). The values which in the tables appear in heavy faced type are experimental results; all others are derived. Tables XVI. to XXI., inclusive, give values for straight stacks, each table representing a different height.

TABLE XVI.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 16 Ins.

Front End of Boiler Diameter in Ins.	Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches. Tip Below Center 20	15	10	5	Tip on Center	Tip Above Center 5	10	15	20	25
30	....	10.6	9.7	8.7	7.8	6.9	5.9	....	....	....
32	....	11.1	10.2	9.2	8.3	7.4	6.4	....	....	....
34	....	11.6	10.7	9.7	8.8	7.9	6.9	....	....	....
36	....	12.1	11.2	10.2	9.3	8.4	7.4	....	....	....
38	13.6	12.6	11.7	10.7	9.8	8.9	7.9	7.0	....	....
40	14.2	13.2	12.3	11.3	10.4	9.5	8.5	7.6	....	....
42	14.7	13.7	12.8	11.8	10.9	10.0	9.0	8.1	....	....
44	15.2	14.2	13.3	12.3	11.4	10.5	9.5	8.6	....	....
46	15.7	14.7	13.7	12.7	11.9	11.0	10.0	9.1	8.1	....
48	16.2	15.2	14.3	13.3	12.4	11.5	10.5	9.6	8.6	....
50	16.8	15.8	14.9	13.9	13.0	12.1	11.1	10.2	9.2	....
52	17.3	16.3	15.4	14.4	13.5	12.6	11.6	10.7	9.7	....
54	**17.8**	**16.8**	**15.9**	**14.9**	**14.1**	**13.1**	**12.1**	**11.2**	**10.2**	**9.3**
56	18.3	17.3	16.4	15.4	14.6	13.6	12.6	11.7	10.7	9.8
58	18.8	17.8	16.9	15.9	15.0	14.1	13.1	12.2	11.2	10.3
60	19.4	18.4	17.5	16.5	15.6	14.7	13.7	12.8	11.8	10.9
62	19.9	18.9	18.0	17.0	16.1	15.2	14.2	13.3	12.3	11.4
64	20.4	19.4	18.5	17.5	16.6	15.7	14.7	13.8	12.8	11.9
66	20.9	19.9	19.0	18.0	17.1	16.2	15.2	14.3	13.3	12.4
68	21.4	20.4	19.5	18.5	17.6	16.7	15.7	14.8	13.8	12.9
70	2.20	21.0	20.1	19.1	18.2	17.3	16.3	15.4	14.4	13.5
72	22.5	21.5	20.6	19.6	18.7	17.8	16.8	15.9	14.9	14.0
74	23.0	22.0	21.1	20.1	19.2	18.3	17.3	16.4	15.4	14.5
76	23.5	22.5	21.6	20.6	19.7	18.8	17.8	16.9	15.9	15.0
78	24.0	23.0	22.1	21.1	20.2	19.3	18.3	17.4	16.4	15.5
80	24.6	23.6	22.7	21.7	20.8	19.9	18.9	18.0	17.0	16.1
82	25.1	24.1	23.2	22.2	21.3	20.4	19.4	18.5	17.5	16.6
84	25.6	24.6	23.7	22.7	21.8	20.9	19.9	19.0	18.0	17.1
86	26.1	25.1	24.2	23.2	22.3	21.4	20.4	19.5	18.5	17.6
88	26.5	25.6	24.7	23.7	22.8	21.9	20.9	20.0	19.0	18.1
90	27.2	26.2	25.3	24.3	23.4	22.5	21.5	20.6	19.6	18.7

TABLE XVII.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 26 Ins.

Front End of Boiler Diameter in Ins.	Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches. Tip Below Center 20	15	10	5	Tip on Center	Tip Above Center 5	10	15	20	25
30	....	11.2	10.5	9.3	8.4	7.5	6.5	....	....	....
32	....	11.7	10.7	9.7	8.9	8.0	7.0	....	....	....
34	....	12.2	11.3	10.3	9.4	8.5	7.5	....	....	....
36	....	12.8	11.9	10.9	10.0	9.1	8.1	....	....	....
38	14.4	13.4	12.5	11.5	10.6	9.7	8.7	7.8	....	....
40	15.1	14.1	13.2	12.1	11.2	10.3	9.3	8.4	....	....
42	15.6	14.6	13.7	12.7	11.8	10.9	9.9	9.0	....	....
44	16.2	15.2	14.3	13.3	12.4	11.5	10.5	9.6	....	....
46	16.7	15.7	14.8	13.8	12.9	12.0	11.0	10.1	9.1	....
48	17.3	16.3	15.4	14.4	13.5	12.6	11.6	10.7	9.7	....
50	17.8	16.8	15.9	14.9	14.0	13.1	12.1	11.2	10.2	....
52	18.3	17.3	16.4	15.4	14.5	13.6	12.6	11.7	10.7	....
54	**18.8**	**17.8**	**16.9**	**15.9**	**15.0**	**14.1**	**13.1**	**12.2**	**11.2**	**10.3**
56	19.3	18.3	17.4	16.4	15.5	14.6	13.6	12.7	11.7	10.8
58	19.9	18.9	18.0	17.0	16.1	15.2	14.2	13.3	12.3	11.4
60	20.4	19.4	18.5	17.5	16.6	15.7	14.7	13.8	12.8	11.9
62	21.0	20.0	19.1	18.1	17.2	16.3	15.3	14.4	13.4	12.5
64	21.5	20.5	19.6	18.6	17.7	16.8	15.8	14.9	13.9	13.0
66	22.1	21.1	20.2	19.2	18.3	17.4	16.4	15.5	14.5	13.6
68	22.6	21.6	20.7	19.7	18.8	17.9	16.9	16.0	15.0	14.1
70	23.2	22.2	21.3	20.3	19.4	18.5	17.5	16.6	15.6	14.7
72	23.7	22.7	21.8	20.8	19.9	19.0	18.0	17.1	16.1	15.2
74	24.3	23.3	22.4	21.4	20.5	19.6	18.6	17.7	16.7	15.8
76	24.8	23.8	22.9	21.9	21.0	20.1	19.1	18.2	17.2	16.3
78	25.4	24.4	23.5	22.5	21.6	20.7	19.7	18.8	17.8	16.9
80	25.9	24.9	24.0	23.0	22.1	21.2	20.2	19.3	18.3	17.4
82	26.5	25.5	24.6	23.6	22.7	21.8	20.8	19.9	18.9	18.0
84	27.0	26.0	25.1	24.1	23.2	22.3	21.3	20.4	19.4	18.5
86	27.7	26.7	25.8	24.8	23.9	23.0	22.0	21.1	20.1	19.2
88	28.1	27.1	26.2	25.2	24.3	23.4	22.4	21.5	20.5	19.6
90	29.8	28.8	27.9	26.9	25.0	24.1	23.1	22.2	21.2	20.3

TABLE XVIII.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 36 Ins.

Front End of Boiler Diameter in Ins.	Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches. Tip Below Center 20	15	10	5	Tip on Center	Tip Above Center 5	10	15	20	25
30	....	11.5	10.6	9.6	8.7	7.8	6.8	....	....	....
32	....	12.0	11.1	10.1	9.2	8.3	7.3	....	....	....
34	....	12.6	11.7	10.7	9.8	8.9	7.9	....	....	....
36	....	13.2	12.3	11.3	10.4	9.5	8.5	....	....	....
38	14.8	13.8	12.9	11.9	11.0	10.1	9.1	8.2	....	....
40	15.4	14.4	13.5	12.5	11.6	10.7	9.7	8.8	....	....
42	15.9	14.9	14.0	13.0	12.1	11.2	10.2	9.3	....	....
44	16.7	15.7	14.6	13.6	12.7	11.8	10.8	9.9	....	....
46	17.1	16.1	15.2	14.2	13.3	12.4	11.4	10.5	9.5	....
48	17.7	16.7	15.8	14.8	13.9	13.0	12.0	11.1	10.1	....
50	18.2	17.2	16.3	15.3	14.5	13.6	12.6	11.7	10.7	....
52	18.8	17.8	16.9	15.9	15.0	14.1	13.1	12.2	11.2	....
54	**19.4**	**18.4**	**17.5**	**16.5**	**15.6**	**14.7**	**13.7**	**12.8**	**11.8**	**10.9**
56	20.0	19.0	18.1	17.1	16.2	15.3	14.3	13.4	12.4	11.5
58	20.6	19.6	18.7	17.7	16.8	15.9	14.9	14.0	13.0	12.1
60	21.2	20.2	19.3	18.3	17.4	16.5	15.5	14.6	13.6	12.7
62	21.7	20.7	19.8	18.8	17.9	17.0	16.0	15.1	14.1	13.2
64	22.3	21.3	20.4	19.4	18.5	17.6	16.6	15.7	14.7	13.8
66	22.9	21.9	21.0	20.0	19.1	18.2	17.2	16.3	15.3	14.4
68	23.5	22.5	21.6	20.6	19.7	18.8	17.8	16.9	15.9	15.0
70	24.1	23.1	22.2	21.2	20.3	19.4	18.4	17.5	16.5	15.6
72	24.6	23.6	22.7	21.7	20.8	19.9	18.9	18.0	17.0	16.1
74	25.2	24.2	23.3	22.3	21.4	20.5	19.5	18.6	17.6	16.7
76	25.8	24.8	23.9	22.9	22.0	21.1	20.1	19.2	18.2	17.3
78	26.4	25.4	24.5	23.5	22.6	21.7	20.7	19.8	18.8	17.9
80	27.2	26.2	25.3	24.3	23.2	22.3	21.3	20.4	19.4	18.5
82	27.5	26.5	25.6	24.6	23.7	22.8	21.8	20.9	19.9	19.0
84	28.1	27.1	26.2	25.2	24.3	23.4	22.4	21.5	20.5	19.6
86	28.7	27.7	26.8	25.8	24.9	24.0	23.0	22.1	21.1	20.2
88	29.3	28.3	27.4	26.4	25.5	24.6	23.6	22.7	21.7	20.8
90	29.9	28.9	28.0	27.0	26.1	25.2	24.2	23.3	22.3	21.4

TABLE XIX.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 46 Ins.

Front End of Boiler Diameter in Ins.	Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches. Tip Below Center 20	15	10	5	Tip on Center	Tip Above Center 5	10	15	20	25
30	....	11.8	10.9	9.9	9.0	8.1	7.1	....	....	....
32	....	12.4	11.5	10.5	9.6	8.7	7.7	....	....	....
34	....	13.0	12.1	11.1	10.2	9.3	8.3	....	....	....
36	....	13.6	12.7	11.7	10.8	9.9	8.9	....	....	....
38	15.2	14.2	13.3	12.3	11.4	10.5	9.5	8.6	....	....
40	15.8	14.8	13.9	12.9	12.0	11.1	10.1	9.2	....	....
42	15.5	15.5	14.6	13.6	12.7	11.8	10.8	9.9	....	....
44	17.1	16.1	15.2	14.2	13.3	12.4	11.4	10.5	....	....
46	17.7	16.7	15.8	14.8	13.9	13.0	12.0	11:1	10.1	....
48	18.3	17.3	16.4	15.4	14.5	13.6	12.6	11.7	10.7	....
50	18.9	17.9	17.0	16.0	15.1	14.2	13.2	12.3	11.3	....
52	19.5	18.5	17.6	16.6	15.7	14.8	13.8	12.9	11.9	....
54	**19.1**	**18.1**	**18.2**	**17.2**	**16.3**	**15.4**	**14.4**	**13.5**	**12.5**	**11.6**
56	20.7	19.7	18.8	17.8	16.9	16.0	15.0	14.1	13.1	12.2
58	21.3	20.3	19.4	18.4	17.5	16.6	15.6	14.7	13.7	12.8
60	21.9	20.9	20.0	19.0	18.1	17.2	16.2	15.3	14.3	13.4
62	22.5	21.5	20.6	19.6	18.7	17.8	16.8	15.9	14.9	14.0
64	23.1	22.1	21.2	20.2	19.3	18.4	17.4	16.5	15.5	14.6
66	23.7	22.7	21.8	20.8	19.9	19.0	18.0	17.1	16.1	15.2
68	24.3	23.3	22.4	21.4	20.5	19.6	18.6	17.7	16.7	15.8
70	24.9	23.9	23.0	22.0	21.1	20.2	19.2	18.3	17.3	16.4
72	25.5	24.5	23.6	22.6	21.7	20.8	19.8	18.9	17.9	17.0
74	26.1	25.1	24.2	23.2	22.3	21.4	20.4	19.5	18.5	17.6
76	26.7	25.7	24.8	23.8	22.9	22.0	21.0	20.0	19.1	18.2
78	27.3	26.3	25.4	24.4	23.5	22.6	21.6	20.7	19.7	18.8
80	27.9	26.9	26.0	25.0	24.1	23.2	22.2	21.3	20.3	19.4
82	28.5	27.5	26.6	25.6	24.7	23.8	22.8	21.9	20.9	20.0
84	29.1	28.1	27.2	26.2	25.3	24.4	23.4	22.5	21.5	20.6
86	29.7	28.7	27.8	26.8	25.9	25.0	24.0	23.1	22.1	21.2
88	30.3	29.3	28.4	27.4	26.5	25.6	24.6	23.7	22.7	21.8
90	30.9	29.9	29.0	28.0	27.1	26.2	25.2	24.3	23.3	22.4

TABLE XX.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 56 Ins.

Front End of Boiler Diameter in Ins.	Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches. Tip Below Center 20	15	10	5	Tip on Center	Tip Above Center 5	10	15	20	25
30	....	12.2	11.3	10.3	9.4	8.5	7.5	....	....	....
32	....	12.8	11.9	10.9	10.0	9.1	8.1	....	....	....
34	....	13.4	12.5	11.5	10.6	9.7	8.7	....	....	....
36	....	14.2	13.3	12.3	11.3	10.4	9.4	....	....	....
38	15.7	14.7	13.8	12.8	11.9	11.0	10.0	9.1	....	....
40	16.3	15.3	14.4	13.4	12.5	11.6	10.6	9.7	....	....
42	16.9	15.9	15.0	14.0	13.1	12.2	11.2	10.3	....	....
44	17.6	16.6	15.7	14.7	13.8	12.9	11.9	11.0	....	....
46	18.2	17.2	16.3	15.3	14.4	13.5	12.5	11.6	10.6	....
48	18.8	17.8	16.9	15.9	15.0	14.1	13.1	12.2	11.2	....
50	19.5	18.5	17.6	16.6	15.7	14.8	13.8	12.9	11.9	....
52	20.1	19.1	18.2	17.2	16.3	15.4	14.4	13.5	12.5	....
54	**20.8**	**19.8**	**18.9**	**17.9**	**17.0**	**16.1**	**15.1**	**14.2**	**13.2**	**12.3**
56	21.4	20.4	19.5	18.5	17.6	16.7	15.7	14.8	13.8	12.9
58	22.0	21.0	20.1	19.1	18.2	17.3	16.3	15.4	14.4	13.5
60	22.6	21.6	20.7	19.7	18.8	17.9	16.9	16.0	15.0	14.1
62	23.2	22.2	21.3	20.3	19.4	18.5	17.5	16.6	15.6	14.7
64	23.8	22.8	21.9	20.9	20.0	19.1	18.1	17.2	16.2	15.3
66	24.5	23.5	22.6	21.6	20.7	19.8	18.8	17.9	16.9	16.0
68	25.1	24.1	23.2	22.2	21.3	20.4	19.4	18.5	17.5	16.6
70	25.7	24.7	23.8	22.8	21.9	21.0	20.0	19.1	18.1	17.2
72	26.4	25.4	24.5	23.5	22.6	21.7	20.7	19.8	18.8	17.9
74	27.0	26.0	25.1	24.1	23.2	22.3	21.3	20.4	19.4	18.5
76	27.7	26.7	25.8	24.8	23.9	23.0	22.0	21.1	20.1	19.2
78	28.3	27.3	26.4	25.4	24.5	23.6	22.6	21.7	20.7	19.8
80	28.9	27.9	27.0	26.0	25.1	24.2	23.2	22.3	21.3	20.4
82	29.5	28.5	27.6	26.6	25.7	24.8	23.8	22.9	21.9	21.0
84	30.1	29.1	28.2	27.2	26.3	25.4	24.4	23.5	22.5	21.6
86	30.8	29.8	28.9	27.9	27.0	26.1	25.1	24.2	23.2	22.3
88	31.4	30.4	29.5	28.5	27.6	26.7	25.7	24.8	23.8	22.9
90	32.0	31.0	30.1	29.1	29.2	27.3	26.3	25.4	24.4	23.5

TABLE XXI.

Straight Stacks.

Diameter of Stack when Its Height Above Boiler Is 66 Ins.

Front End of Boiler Diameter in Ins.	Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches. Tip Below Center 20	15	10	5	Tip on Center	Tip Above Center 5	10	15	20	25
30	....	12.5	11.6	10.6	9.7	8.8	7.8	....	....	....
32	....	13.2	12.3	11.3	10.4	9.5	8.5	....	....	....
34	....	13.8	12.9	11.9	11.0	10.1	9.1	....	....	....
36	....	14.5	13.6	12.6	11.7	10.8	9.8	....	....	....
38	16.1	15.1	14.2	13.2	12.3	11.4	10.4	9.5	....	....
40	16.8	15.8	14.9	13.9	13.0	12.1	11.1	10.2	....	....
42	17.4	16.4	15.5	14.5	13.6	12.7	11.7	10.8	....	....
44	18.1	17.1	16.2	15.2	14.3	13.4	12.4	11.5	....	....
46	18.7	17.7	16.8	15.8	14.9	14.0	13.0	12.1	11.1	....
48	19.4	18.4	17.5	16.5	15.6	14.7	13.7	12.8	11.8	....
50	20.0	19.0	18.1	17.1	16.2	15.3	14.3	13.4	12.4	....
52	20.7	19.7	18.8	17.8	16.9	16.0	15.0	14.1	13.1	....
54	**21.4**	**20.4**	**19.5**	**18.5**	**17.6**	**16.7**	**15.7**	**14.8**	**13.8**	**12.9**
56	22.0	21.0	20.1	19.1	18.2	17.3	16.3	15.4	14.4	13.5
58	22.7	21.7	20.8	19.8	18.9	18.0	17.0	16.1	15.1	14.2
60	23.3	22.3	21.4	20.4	19.5	18.6	17.6	16.7	15.7	14.8
62	24.0	23.0	22.1	21.1	20.2	19.3	18.3	17.4	16.4	15.5
64	24.6	23.6	22.7	21.7	20.8	19.9	18.9	18.0	17.0	16.1
66	25.3	24.3	23.4	22.4	21.5	20.6	19.6	18.7	17.7	16.8
68	25.9	24.9	24.0	23.0	22.1	21.2	20.2	19.3	18.3	17.4
70	26.6	25.6	24.7	23.7	22.8	21.9	20.9	20.0	19.0	18.1
72	27.2	26.2	25.3	24.3	23.4	22.5	21.5	20.6	19.6	18.7
74	28.9	27.9	26.0	25.0	24.1	23.2	22.2	21.3	20.3	19.4
76	28.5	27.5	26.6	25.6	24.7	23.8	22.8	21.9	20.9	20.0
78	29.2	28.2	27.3	26.3	25.4	24.5	23.5	22.6	21.6	20.7
80	29.8	28.8	27.9	26.9	26.0	25.1	24.1	23.2	22.2	21.3
82	30.5	29.5	28.6	27.6	26.7	25.8	24.8	23.9	22.9	22.0
84	31.1	30.1	29.2	28.2	27.3	26.4	25.4	24.5	23.5	22.6
86	31.8	30.8	29.9	28.9	28.0	27.1	26.1	25.2	24.2	23.3
88	32.4	31.4	30.5	29.5	28.6	27.7	26.7	25.8	24.8	23.9
90	33.1	32.1	31.2	30.2	29.3	28.4	27.4	26.5	25.5	24.6

TABLE XXII.

Taper Stacks.

Diameter at Chock of Stack for any Height when Stack Tapers 2 Ins. to the Foot.

Front End of Boiler Diameter in Ins.	Distance Between Center Line of Boiler and Top of Exhaust Tip. Inches. Tip Below Center 20	15	10	5	Tip on Center	Tip Above Center 5	10	15	20	25
30	....	....	9.1	8.3	7.5	6.7	5.9	....	....	....
32	....	....	9.6	8.8	8.0	7.2	6.4	....	....	....
34	....	10.9	10.1	9.3	8.5	7.7	6.9	....	....	....
36	....	11.4	10.6	9.8	9.0	8.2	7.4	....	....	....
38	12.7	11.9	11.1	10.3	9.5	8.7	7.9	7.1	....	....
40	13.2	12.4	11.6	10.8	10.0	9.2	8.4	7.6	....	....
42	13.7	12.9	12.1	11.3	10.5	9.7	8.9	8.1	....	....
44	14.2	13.4	12.6	11.8	11.0	10.2	9.4	8.6	....	....
46	14.7	13.9	13.1	12.3	11.5	10.7	9.9	9.1	8.3	....
48	15.2	14.4	13.6	12.8	12.0	11.2	10.4	9.6	8.8	....
50	15.7	14.9	14.1	13.3	12.5	11.7	10.9	10.1	9.3	....
52	16.2	15.4	14.6	13.8	13.0	12.2	11.4	10.6	9.8	....
54	**16.7**	**15.9**	**15.1**	**14.3**	**13.5**	**12.7**	**11.9**	**11.1**	**10.3**	**9.5**
56	17.2	16.4	15.6	14.8	14.0	13.2	12.4	11.6	10.8	10.0
58	17.7	16.9	16.1	15.3	14.5	13.7	12.9	12.1	11.3	10.5
60	18.2	17.4	16.6	15.8	15.0	14.2	13.4	12.6	11.8	11.0
62	18.7	17.9	17.1	16.3	15.5	14.7	13.9	13.1	12.3	11.5
64	19.2	18.4	17.6	16.8	16.0	15.2	14.4	13.6	12.8	12.0
66	19.7	18.9	18.1	17.3	16.5	15.7	14.9	14.1	13.3	12.5
68	20.2	19.4	18.6	17.8	17.0	16.2	15.4	14.6	13.8	13.0
70	20.7	19.9	19.1	18.3	17.5	16.7	15.9	15.1	14.3	13.5
72	21.2	20.4	19.6	18.8	18.0	17.2	16.4	15.6	14.8	14.0
74	21.7	20.9	20.1	19.3	18.5	17.7	16.9	16.1	15.3	14.5
76	22.2	21.4	20.6	19.8	19.0	18.2	17.4	16.6	15.8	15.0
78	22.7	21.9	21.1	20.3	19.5	18.7	17.9	17.1	16.3	15.5
80	23.2	22.4	21.6	20.8	20.0	19.2	18.4	17.6	16.8	16.0
82	23.7	22.9	22.1	21.3	20.5	19.7	18.9	18.1	17.3	16.5
84	24.2	23.4	22.6	21.8	21.0	20.2	19.4	18.6	17.8	17.0
86	24.7	23.9	23.1	22.3	21.5	20.7	19.9	19.1	18.3	17.5
88	25.2	24.4	23.6	22.8	22.0	21.2	20.4	19.6	18.8	18.0
90	25.7	24.9	24.1	23.3	22.5	21.7	20.9	20.1	19.3	18.5

TABLE XXIII.

Best Draft.

Obtainable Under Conditions of Constant Speed and Cut-Off with Different Heights of Stack in Connection with Different Heights of Exhaust Nozzle.

Nozzle.	1 Draft.	Difference.	2 Draft.	Difference	3 Draft.	Difference.	4 Draft.	Difference.	5 Draft.	Difference	6 Draft.	Difference.	7 Draft.	Difference.
Stack 2—D	4.0	...	4.2	...	4.0	...	3.9	...	4.0	...	3.4	...	3.2	...
Stack 2—C	3.5	.5	3.8	.4	3.7	.3	3.5	.4	3.5	.5	3.1	.3	2.7	.5
Stack 2—B	3.1	.4	3.2	.6	3.3	.4	3.0	.5	2.9	.6	2.5	.6	2.2	.5
Stack 2—A	2.3	.8	2.4	.8	2.6	.7	2.4	.6	2.2	.7	2.0	.5	1.6	.6
Total difference.		1.7		1.8		1.4		1.5		1.8		1.4		1.6

44. *Unavoidable Loss of Draft with Reduction in Height of Stack.*—The equations already presented, together with the tabulated statements based thereon, are assumed to give the best diameter for a stack of any given height. They can not be depended upon to give results which will always be satisfactory under conditions which greatly limit or restrict the height. In general, the best draft obtainable from a short stack is inferior to that obtained from a longer stack. The most that can be done when the limit of height has been fixed is to determine a diameter which, in combination with that height, will give best results. It is this and this only that the equations, and the tables based thereon, are assumed to do.

The rate at which the draft diminishes with each reduction in height of stack is indicated by Figs. 103 to 106, presenting results plotted in terms of draft and stack-height. In explanation of these figures it should be noted that the stack-heights represented are: Base, 16½ ins.; A, 26½ ins.; B, 36½ ins.; C, 46½ ins., and D, 56½ ins. Figure 103 gives results with the smallest tapered stack in combination with the lowest nozzle; Fig. 104 those for the largest tapered stack in combination with the lowest nozzle, and Figs. 105 and 106 those for the smallest and the largest tapered stacks, respectively, for a series of tests at different cut-offs. In all of these figures it will be seen that there is a marked decrease in the draft obtained for each reduction in the height of stack. This is the more significant when it is considered that these diagrams represent only tapered stacks and that the diameter of the choke of such stacks is not required to be changed when the stack is varied in height. It is clear, therefore, that these diagrams confirm the statement already made to the effect that a short stack, however well designed, must be inferior in its draft-producing qualities to a longer stack of good design. There is, in fact, nothing in the relation of diameter to height, or, so far as the investigation has proceeded, in the form of the stack itself, which can be accepted as a complete substitute for height. Again, this loss in draft with changes in height of stack does not depend upon the height of the nozzle. Thus, Table XXIII. represents a summary of results in connection with all heights of the smallest tapered stack in combination with all heights of nozzle. The table shows that whatever the height of the nozzle, the loss in draft under the conditions represented in passing from the D, or 56½ in. height, to the A, or 26½ in. height, is a fixed quantity and under the conditions of the tests referred to is approximately represented by 1.6 in. of water. Thus, for the nozzle No. 1, it is 1.7 in.; for the nozzle No. 3, 1.4 in.; for the nozzle No. 5, 1.8 in.; for the nozzle No. 7, 1.6 in.

It is difficult to find a quantitative measure for the loss of draft resulting from reduction in height of stack which will be of general application. The extent of such loss is, however, suggested by the slope of the lines in the figures already referred to, and by the differences in Table XXIII. The general conclusion is, however, clear. It is apparent that the shorter stacks are far inferior to those of greater length and that the maintenance of draft values in connection therewith must necessarily involve the application of additional mechanism, or an increase in the energy of the exhaust jet. The present study does not suffice to indicate what should be the character of such additional mechanism or the extent of the necessary increase in the energy of the exhaust jet. It is, however, altogether possible that the adoption of some form of inside stack or of draft-pipes may make good the loss resulting from the diminished length of outside stack.

45. *Relative Advantage of Straight and Tapered Stacks.*—But two forms of stacks were employed in the experiments under discussion, one being perfectly cylindrical, and hence referred to as the straight stack; the other having the form best shown by Fig. 26, and generally referred to as the tapered stack. This tapered stack has its least diameter, or "choke," at a point 16½ ins. from the bottom and increases in diameter uniformly above this point, the angle of the sides being the same for all stacks, and the divergence being at the rate of 2 ins. in diameter for each foot in length. This divergence corresponds with that which was found best, as a result of the well-known von Borries-Troske tests. The most noteworthy difference in results obtained from the two contours is to be found in the increased capacity of the tapered stack. Thus, No. 2 stack (9¾ ins. diameter), which is the smallest of the tapered stacks, gives draft values which are two or three times as great as those obtained with No. 1, which is a straight stack of the same diameter. While the results from No. 2 are none of them sufficiently meritorious to warrant a place in the table of best results (Table XV.), they give a close approach thereunto. The two smaller diameters of straight stacks, Nos. 1 and 3 (9¾ ins. and 11¾ ins. diameter) are both far too small to yield results which are to be regarded as satisfactory, the capacity of these stacks being insufficient for the work expected of them. Speaking in rather general

terms, it may be said that a tapered stack having a diameter of choke 9¾ ins. has as great a capacity as a cylindrical stack of 13¾ ins. Again, only the largest diameter of straight stack, No. 7 (15¾ in. diameter) has a place in the table of best results, whereas all diameters of the tapered stack excepting the least, find places in the table. It is of interest to note that with the low nozzle, tapered stack 6 B (least diameter 13¾ ins., total height 36½ ins.) gives identical results with straight stack 7 C (diameter 15¾ ins., height 46½ ins.), the tapered stack being 10 ins. lower and 2 ins. less in diameter than the straight stack.

It has been stated (Article 40) that whereas for best results,

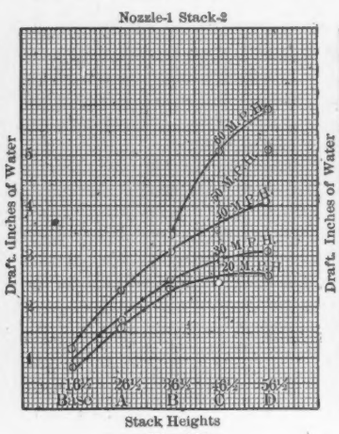


Fig. 103

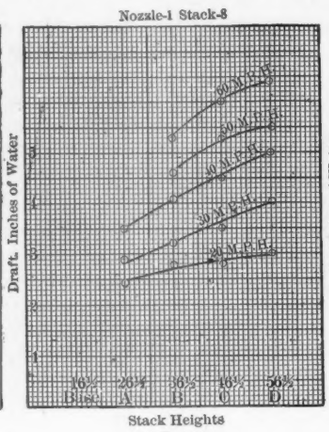


Fig. 104

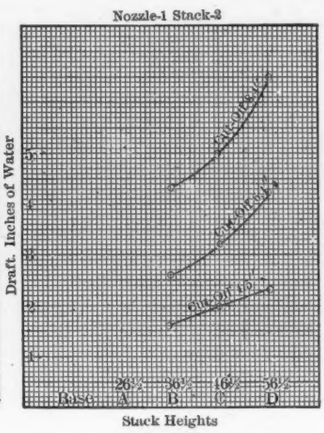


Fig. 105

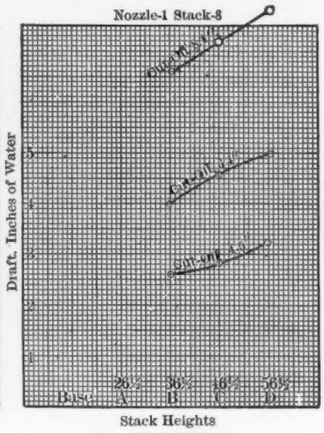


Fig. 106

the diameter of the straight stack must change for every change in height, that of the tapered stack remains constant for all heights. In this connection, it is important to remember that the diameter of the tapered stacks referred to is the diameter of the choke (least diameter). As a matter of fact, if designs based on the equations which have been deduced were to be superimposed they will show that while the tapered stack, as compared with the straight stack, is of a lesser diameter at the choke, the diameter of its top will generally exceed that of the straight stack.

In general, it would seem that the tapered stack is less susceptible to minor changes of proportion, both of the stack itself and of the surrounding mechanism, than the straight stack. Thus, a variation of an inch or two in the diameter of the tapered stack affects the draft less than a similar change in the diameter of the straight stack. Again, the tapered stack is generally less affected by variations in the height of the nozzle so that altogether it appears, quite contrary to the expectation of the experimenter, that the use of the tapered stack gives a greater degree of flexibility in the design of the dependent parts. *For these reasons, in the opinion of the undersigned, the tapered form appears to be altogether preferable to the straight form.*

46. *Draft, a Function of Weight of Steam Exhausted.*—Attention has already been called to the fact that a good arrangement of nozzle and stack appears to be equally efficient under whatever conditions the engine may run. A combination which is good for one speed is good for all speeds, and a combination which is good for one cut-off is good for all cut-offs. While this is true, it goes without saying that draft values change when there is a change in the manner of running; that at a constant cut-off, an increase of speed increases draft values; and at a constant speed and throttle opening, increasing the cut-off, increases the draft values. In other words, whatever tends to increase the volume of steam exhausted in a given time, augments the draft values. When the number of pounds of steam exhausted per minute is doubled, the draft as measured in inches of water is doubled. These facts have already been presented in another connection (Article 38), and are repeated here by way of emphasis. The extent to which the general statement is true appears in the comparisons made possible by Table XIV.

47. *Inside Stacks.*—The original outline of tests contained no reference to inside stacks. When, however, the work originally provided for had been completed, it was suggested that a start be made upon the inside stack and to a limited extent this was done.

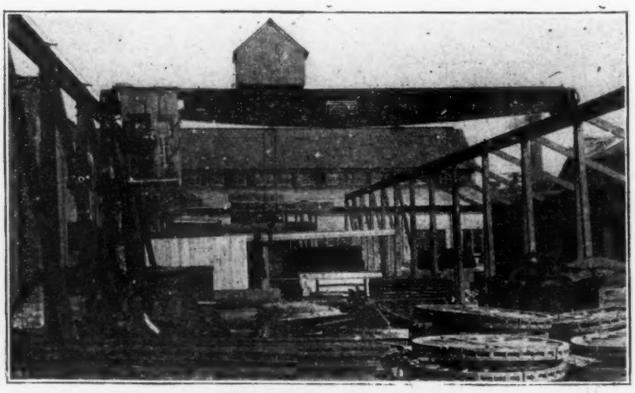
Before attempting to discuss inside stacks, it should be remembered that the results of tests involving outside stacks show that when other things are unchanged, the higher the stack, the better the draft; that when, through increased diameter of the boiler, it becomes necessary to reduce the height of the stack, there inevitably results a loss in draft. This being true of the outside stack, it becomes important to know whether an extension of the stack downward into the smoke-box will serve to hold up the efficiency of the draft when the length of the outside portion of the stack is diminished. In a discussion of this matter at the Convention of the American Master Mechanics' Association at Saratoga in June last (1902) the undersigned expressed the opinion that the extension of the stack downward into the smoke-box would in part compensate for the loss of length outside of the smoke-box. Since that time the matter has received careful attention and while the material at hand will hardly sustain a definite conclusion, it points to a conclusion and is of sufficient interest to warrant its presentation.

(To be Concluded.)

STOREHOUSE YARD CRANE.

CHICAGO & NORTHWESTERN RAILWAY.

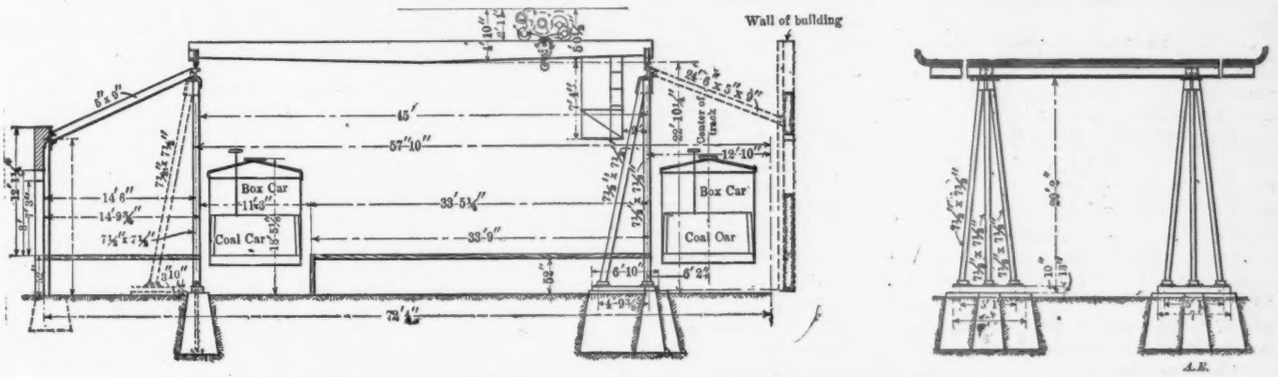
At the general storehouse of this road at the Chicago shops a large amount of heavy material is kept in stock and frequently handled. In order to reduce the labor cost an inexpensive and effective crane service was arranged by Mr. G. F.



STOREHOUSE YARD CRANE.

Slaughter, formerly general storekeeper of the road. The crane has a span of 45 ft. and the runway is supported on wooden frames spanning that portion of the yard in which such material as driving-wheel centers, ties, cylinders, frogs, pilots, boiler fronts and other heavy parts are stored. The

crane lifts five tons and is driven by motors, taking current from the power circuit of the shops. The idea of a crane for handling storehouse material is not new, but present conditions require such apparatus in all large storehouse establishments, and there can be few small investments which will give such large returns in the reduction of labor charges. With this crane two men do the work formerly requiring ten. The runway is 475 ft. long. Every large storehouse should have such facilities.



STOREHOUSE YARD CRANE.—CHICAGO & NORTHWESTERN RAILWAY.

We are indebted to Mr. Robert Quayle, superintendent of motive power, and Mr. W. E. Dunham, mechanical engineer, for the drawing and photograph.

MASTER MECHANICS' ASSOCIATION.

THIRTY-SIXTH ANNUAL CONVENTION.

ABSTRACTS OF REPORTS.—CONTINUED.

PISTON VALVES.

In the discussion of the report of the committee on this subject, which appeared in abstract on page 274 of our July number, Mr. John Player presented the following remarks:

One of the first questions brought up in the paper was the relative use of the hollow or solid-ended piston valve. The report states that the preference seems to be for the hollow valve, that is, with the exhaust cavity passing entirely through the valve. The original piston valves which we constructed, and which other roads have also applied, had the hollow cavity for the exhaust, with the supposition of producing an entirely balanced valve. We found, however, with that valve that at the period of commencement of exhaust the exhaust pressure had a tendency to accelerate the motion of the valve, or in other words, increase the pressure against the exhaust packing ring. There was an objection at that time, chiefly raised by engineers, to the sound of the exhaust of the piston valve, that it was muffled; it was, in comparison to the exhaust of a slide valve. We also found that the exhaust was not quite as sharp from the piston-valve engine, although you could run with a nozzle the same size as with slide-valve engines, yet the exhaust did not sound as sharp and there was a tendency to close up the exhaust tips to produce the sound. To overcome that we made the ends of the valve followers solid and built a great number of engines with the ordinary two-opening exhaust, with both cavities opening into the same chamber, same as with a slide valve. We found that the acceleration of the valve at the period of commencement of exhaust was practically not increased to any appreciable extent by making the ends solid. Shortly after that we introduced a further betterment in the adoption of a four-opening exhaust, by making two exhaust cavities in each cylinder entirely separate, and carrying them upward in the exhaust pipe, and making the exhaust pipe with four openings at the base, carrying two a portion of the way up and the other two higher, the proportions of the exhaust pipe above that being approximately the same as those recommended by the association. We found by the adoption of this exhaust cavity and pipe we were able to enlarge the nozzles on an identically similar engine, enlarging the exhaust tip anywhere from 3-16 to ⅜ of an inch, showing the benefit of the solid end valve with the separate exhaust. The objection that has been raised that there was an exhaust pressure on the ends of the valve, does not hold in this case. For one thing, we get a larger opening at the exhaust tip which relieves the back pressure. The indicator cards show the back pressure is lower than that in any slide-valve engine with open ends. There has been some trouble with relief valves on the cylinder heads. Relief valves with piston valves are a necessity on cylinder heads, especially at high speeds. In some places they screw them down instead of adjusting them at proper pressure, and consequently they do not work. They should be made so that they cannot be "monkeyed" with. As to the by-pass valve, it is beginning to be an appreciated fact that by-pass valves combined with piston valves are a benefit, especially upon engines that have to do drifting. Some of the former patterns of by-pass valves that were applied to piston-valve engines were not altogether a success. The areas were insufficient in the first place, and the construction of the valve was such that they had a tendency to stick, and sufficient attention was not paid to them to keep them in order. All that trouble has been eliminated in the improved form, and they are a necessity upon passenger and freight engines that do much drifting.

With relation to circulation pipes, they perform practically the same function as the by-pass valve, but have a tendency to freeze up which is not a desirable feature. The results accomplished by the circulation pipe can be accomplished by a good construction of by-pass valve. As to the packing rings, reference has been made to the abandonment of substitution of some other form for the L-shaped ring. Some of them were made entirely too light in section, and the projection over the follower was entirely disproportionate to the section of the ring itself in some of the early forms. Any properly proportioned L-shaped ring is the ring to use, as it gives a proper cut-off edge. One objection to using them in solid valves has been there is some trouble in springing them over, so that you start an initial strain in the metal which causes breakage afterward, but with the follower we have there is practically no breakage in the L-shaped rings if the valves are properly lubricated. Regarding the valve stem connections, they should be made flexible where practicable. The valve, in my judgment, should be supported by the stems at both ends in bushings, so as to relieve the weight of the valve on the bushing itself. I have seen valves supported at both ends that ran two years and a half, where the tool marks were scarcely worn off the bottom of the valve.

The advantages in handling these valves have been treated by previous speakers. The cylinder clearance of large engines with slide valves is something abnormal in many cases. The clearance obtainable with piston-valve cylinders varies from 6 to 8 per cent. in a simple engine, although contrary statements have been made. I do not know of any piston-valve engine of recent design where the clearance exceeds 9 per cent. The disadvantage of breaking of packing rings is a local matter; it is due to insufficient lubricating or a fault in the proportion of the ring itself. If proper followers are used and the rings are of proper shape that will disappear. The wear of the packing rings is also largely due to the proportion of the rings. The wear of the driving box on one road mentioned in the report, I believe, was due to the absence of by-pass valve with the proportions of the cylinder used. I think if a by-pass valve were applied on that cylinder the trouble would disappear.

With regard to bushings, the bushings made with slightly tapered bridges have accomplished the same results as angular bridges and are as easy of construction as the ordinary bushing. The lubrication of piston valves is an easy matter. In some forms the lubrication is applied at both ends of the valve instead of one in the center, with very marked benefit.

In regard to Mr. Sinclair's reference to marine valves and the leakage of them, I understand that reference to be to low-pressure engines. If they had so much trouble with piston valves in marine

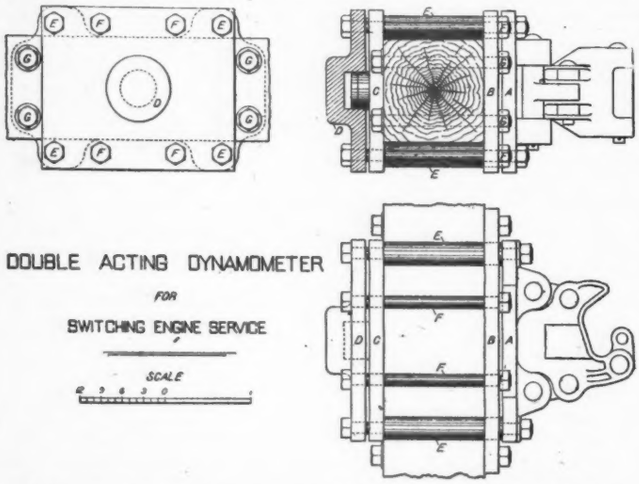
service years ago, why is it that the British Government, the United States Government, and all these large transatlantic steamer lines are using piston valves? If the slide valve is better, why do they not use it?

With regard to the trouble that has been mentioned in handling piston valves, as to the dropping down in the corner and the racking of the valve motion occasioned by it, proper instructions should be issued to engineers for the proper handling of piston-valve engines to the effect that, as the last speaker suggested, the lever should not be dropped down while the engine is speeding, but dropped down gradually as the speed decreases as you are going into a station. The object of this is obvious. The piston valve runs in a bushing, and not over a plain surface like the slide valve. The lubrication for the bushing and valve is taken in the middle, and the lubricated surface is that over which the packing rings travel. The surface covered by the exhaust steam, which is not covered by the travel of the valve when working, becomes dry and encrusted to a certain extent with the scum which you usually find in a steam chest. When you drop the lever in full gear, you have to cut that all off at one stroke, practically speaking, or else it snaps in the packing rings and the packing rings travel over it, and the fact of always dropping the lever down at speed is one of the most serious objections in the use of piston valves. It causes practically all the trouble of breakage of packing rings and the failures of the valve motion referred to. If the valve is handled in a proper manner, not dropped down when running at speed, but as you slow down drop it down gradually, there will be no trouble experienced with the piston-valve cylinder.

A LOCOMOTIVE DYNAMOMETER.

In the discussion of the report on ton mile statistics before the Master Mechanics' Association Mr. G. L. Fowler described a dynamometer, designed by him.

The bumper timber is shown in the upper right hand corner. There is a plate B bolted securely to it by bolts G. This plate is immovable, and is attached to the buffer. The coupler is attached rigidly to the plate A. Passing through the plate A is the bolt E, with a heavy shoulder against the plate A, and also another shoulder against the plate C, so that if A is pushed back by buffing, the plate C is carried back with it. The hydraulic cylinder is shown at D and is bolted by the bolts F to the plate B. If there is a buffing stress applied to the coupler, the plate C is pushed back



and the plunger exerts a pressure in the cylinder. If there is a pulling stress, the plate A is moved away and pulls against the cylinder D by means of the bolts E; but the plate C cannot follow it and comes up against the buffer beam, and that also puts a pressure in the cylinder. A Bristol recording gauge is to be used with this dynamometer.

SPECIFICATIONS FOR LOCOMOTIVE AXLES AND FORGINGS.

COMMITTEE—F. H. CLARK, J. E. SAGUE, S. M. VAUCLAIN, L. B. POMEROY.

First.—To submit specifications for locomotive driving and truck axles.

Second.—To submit specifications for locomotive forgings.

Third.—To co-operate with the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the American Society for Testing Materials, with a view of bringing about standard specifications for locomotive axles and forgings. Your committee, therefore, in presenting the specifications below does not expect their adoption as standard, but hopes that a discussion of the subject will enable the committee to take the matter up with the other associations named with a better understanding of the wishes of this association.

PROPOSED SPECIFICATIONS FOR LOCOMOTIVE DRIVING AND ENGINE TRUCK AXLES.

Material, open-hearth steel.
- Phosphorus, not to exceed..... .05 per cent.
- Sulphur, not to exceed..... .05 per cent.
- Manganese, not to exceed..... .60 per cent.
- Tensile strength—not less than 80,000 lbs. per square inch.
- Elongation in 2 ins., not less than 20 per cent.
- Reduction in area, not less than 35 per cent.

One test per melt will be required, the test specimen to be taken from either end of any axle with a hollow drill, half way between the center and the outside, the hole made by the drill to be not more than 2 ins. in diameter, nor more than 4½ ins. deep. The standard turned test specimen, ½ in. in diameter and 2 ins. gauge length, shall be used to determine the physical properties. (See Fig. 1.) Drillings or turnings from the tensile specimens shall be used to determine the chemical properties.

Each axle must have heat number and manufacturer's name plainly stamped on one end, with stamps not less than ⅜ in., and have order number plainly marked with white lead.

All axles must be free from seams, pipes and other defects, and must conform to drawings accompanying these specifications. Axles must be rough-turned all over, with a flat-nosed tool, cut to exact length, have ends smoothly finished and centered with 60-deg. centers. Axles failing to meet any of the above requirements, or which prove defective on machining, will be rejected.

The above specifications for locomotive driving and truck axles is believed to be fair to both manufacturer and purchaser. The physical test outlined is one which should insure proper hammer work and it has also the following further points in its favor: (1) It does not show the manufacturer which axle is to be selected for test. (2) The axle tested is not destroyed, but is available for use if it meets the requirements. (3) The test may be used in the purchase of small lots, most orders from railroad companies being for from six to ten axles. (4) The test does not require a discard and in no way adds to the cost of the axle. (5) It furnishes the manufacturer with a check of the work done in his plant. (6) The test is one largely used by the United States Government for forgings.

PROPOSED SPECIFICATIONS FOR LOCOMOTIVE FORGINGS.

Material, open-hearth steel.
- Phosphorus, not to exceed..... .05 per cent.
- Sulphur, not to exceed..... .05 per cent.
- Manganese, not to exceed..... .60 per cent.
- Tensile strength, not less than 80,000 lbs. per square inch.
- Elongation, not less than 20 per cent. in 2 ins.
- Reduction in area, not less than 35 per cent.

One test per melt will be required, the test specimen to be cut cold from the forging, or full-sized prolongation of same, parallel to the axis of the forging and half way between the center and the outside. The standard turned specimen, ½ in. in diameter and 2 ins. gauge length, shall be used to determine the physical properties. (See Fig. 1.) Drillings or turnings from the tensile specimen shall be used to determine the chemical properties.

Each forging must have heat number and name of manufacturer plainly stamped on one end with figures not less than ⅜ in. and have order number plainly marked with white lead.

All forgings must conform to drawings which accompany these specifications, and be free from seams, pipes and other defects. Any forgings failing to meet any of the above requirements, or which prove defective on machining, will be rejected.

The above specificaton for locomotive forgings is based upon the recommendation of the American Society for Testing Material, with some slight modifications, which, it is believed, will tend to improve the product. The physical test is substantially the same as that recommended above for testing locomotive driving and truck axles, and the same arguments may be used in its favor.

PROPOSED SPECIFICATIONS FOR STEEL BLOOMS AND BILLETS FOR LOCOMOTIVE FORGINGS.

Material, open-hearth steel.

Grade "A:"
- Tensile strength, 70,000 lbs. per square inch.
- Elongation in 2 ins., 20 per cent.

Grade "B:"
- Tensile strength, 80,000 lbs. per square inch.
- Elongation in 2 ins., 17 per cent.

Grade "A:"
- Carbon ..... .25 to .40 per cent.
- Phosphorus, not to exceed..... .06 per cent.
- Sulphur, not to exceed..... .06 per cent.
- Manganese, not to exceed..... .60 per cent.

Grade "B:"
- Carbon ..... .35 to .50 per cent.
- Phosphorus, not to exceed..... .05 per cent.
- Sulphur, not to exceed..... .05 per cent.
- Manganese, not to exceed..... .60 per cent.

One test per melt should be required, the test specimen to be cut cold from the bloom, parallel to its axis and half way between the center and the outside. The standard turned test specimen, ½ in. in diameter, and 2 ins. gauge length, shall be used to determine the physical properties. (See Fig. 1.) Drillings or turnings from the tensile specimen shall be used to determine the chemical properties.

Each bloom or billet must have heat number and manufacturer's name plainly stamped on one end, with stamps not less than ⅜ in. and have order number plainly marked with white lead.

Blooms and billets must be free from checks, pipes and surface defects. Any blooms or billets chipped to a depth greater than ½ in. will be rejected. Any billet or bloom failing to meet the

above requirements will be rejected and held, subject to disposal by manufacturers. Inspector to have the privilege of taking drillings from the center of the top bloom or billet of the ingot in

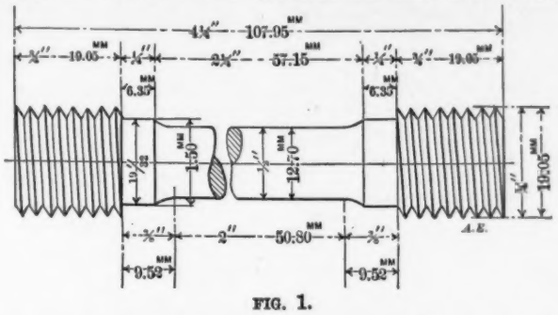


FIG. 1.

order to determine the amount of segregation. Grade "A" is blooms or billets for rod straps and miscellaneous forgings. Grade "B" is blooms or billets for driving and truck axles, connecting rods, crankpins and guides.

INTERNAL COMBUSTION ENGINE IN RAILWAY SERVICE.

AN INDIVIDUAL PAPER BY R. P. C. SANDERSON.

Had the internal combustion engine been invented before the steam engine, it is reasonably certain now that the latter would never have been developed and assumed the important standing in the industrial accomplishment that it has to-day, but the internal combustion engine would be in its place, doing its work and very much more efficient than it is to-day.

The mechanical genius of this country and Europe has, for years, been striving with really wonderful results to improve the efficiency of the steam engine, and when we compare the high pressure, quadruple expansion steam engines with surface condensers of to-day, with the long stroke, low pressure single expansion engines of fifty years ago, the coefficient of efficiency tells the story of the progress made during that interval of time in perfecting the steam engine and boiler.

But, apart from the perfection of workmanship and design of the boiler, and the skill in making the engine develop the greatest amount of power with the least amount of steam, there are inherent losses in the process of converting the energy of coal or oil into power at the crank, which can never be eliminated in the steam engine and boiler. No boiler can be made which will absorb all the heat which can be given by the coal. There is a loss in the boiler due to the evaporation of water into steam, and other losses with which we are all familiar. The process itself is an extravagant and wasteful one.

To illustrate this. If we take an engine of reasonable efficiency in ordinary service (I do not now refer to the highest type of multiple expansion or condensing engines), with a reasonably good boiler, we cannot expect to get a brake horse-power for much less than five or six pounds of coal per horse-power per hour.

In the present imperfect condition of the internal combustion engine there is no difficulty in getting a brake horse-power for one pound of coal per hour from producer gas, where nothing is wasted but the ashes, and, of course, some heat in the producer itself necessarily, due to the change of the carbon from its fixed form into that of fuel gas.

Gas engines are now made not only in the size of toys, but up to 2,500 horse-power units. Formerly the waste gas from the blast furnaces was used in part for heating stationary boilers and furnishing steam to drive the blowing engines for the furnace. These boilers generally had to be supplemented with coal fuel to get enough steam to run the engines. Nowadays the steam boilers and steam engines have given place to powerful internal combustion engines, where the gas from the furnaces is burnt direct in the cylinders of engines and produces all power necessary for doing the blowing. A moment's thought of the immense saving this means in connection with the statement made above with regard to the possibility of producing power for anywhere from one-third to one-eighth of the amount of coal that is now being used for steam purposes in steam engines and boilers will indicate to the minds of members who wish to consider this matter what the possibilities are for the future.

In producing gas, one of the principal troubles and sources of expense of installation is necessitated for gas holders of large capacity to carry a sufficient supply of gas to meet the varying demands. Recent developments, it is understood, have made even this unnecessary, as gas producers, operating continuously, have been invented which furnish gas directly from the producer to engine, and which can be driven with varying capacity to satisfy the demands of the engine, just as a steam boiler is driven to meet the requirements for steam as demanded by the engine.

As gas producers will make good fuel gas from poor coal, without trouble from clinker, and as gas can be successfully used for every purpose in railroad service, not only for producing power, but also for doing work in the shop furnaces, for tinner's work, for blacksmith forges, for welding flues, for flanging and annealing boiler plates, for heavy forgings, for brazing, etc., it is quite practicable at any shop installation to put in a battery of producers, to turn the cheapest grade of slack coal into fuel gas. This can be used for driving individual shops or groups by gas engines located around the plant, if so desired, the gas being taken to them by piping—for all smith shop and foundry purposes, etc., or the gas engines can be located in the central power house and used to drive electric dynamos for power and light, the current being carried by wire to the individual machines or motors for group drivings.

In the West, and in many other parts of the country where water is bad, where the cost of boiler work is heavy on account of incrustation and scale formation, and where the labor for boiler repairs is hard to get and hard to handle, the use of gas power opens up possibilities of which it is believed progressive men will not be slow to take advantage.

A few years ago the horseless carriage was a subject for jest, and had never been a practical success. Now, nearly every street and highway in the country is more or less populated by automobiles of one kind or another. Perhaps the most successful ones are those operated by internal combustion engines. The stimulation which this industry has given to the development of the gas engine is not inconsiderable.

If the little gasoline engines can drive the heavy automobiles a mile in 52 2-5 seconds, which, I believe, is the best record so far, and if the machines can undertake trips of thousands of miles, it is proper to assume that they have become a permanent factor in transportation. What the final effect of this upon railroad passenger service will be it is hard to predict.

As the manufacturing industries and population of this country grow, the demand for additional power and for fuel for heating and lighting will steadily increase the demand for coal at the mines. Sooner or later we will be forced to take radical steps to economize in the consumption of fuel, which fact must be plain to all of those who can look ahead.

The internal combustion engine holds out the opportunity, and about the only opportunity there is in sight to accomplish this end.

Perhaps it is thought that the locomotive will always have to remain a steam locomotive. It is also believed that this is a field which the internal combustion engine will soon invade, and invade successfully. The inventive genius of the country will surely provide a means of building locomotives with continuous gas producers instead of boilers, and with the internal combustion engine instead of the steam engine underneath them. There is no question in the world but that this can be done, and successfully done with crude oil for fuel, and that such engines will operate for practically 20 to 25 per cent. of the cost of fuel that is now necessary with the steam locomotive, that the boiler repairs will be practically eliminated from among railroad troubles, and is further believed that American genius will also find the way to successfully make gas producers acting continuously which will produce the volume of gas needed for heavy locomotive service as required by the engine without any need for storage.

The internal combustion engine has only recently taken a new lease of life; the great minds of the country have only recently set to work to develop it. Its efficiency to-day can be compared with the efficiency of the steam engine fifty years ago; what its efficiency will be ten years from now can only be guessed, but it is quite likely that it will produce a brake horse-power ultimately for ½ lb. of average grade of coal per hour.

It is quite likely that the future will see coal largely turned into gas right at the pit mouth of the mines and either driven through gas mains to the sources of consumption or by gas engines of great power and dynamos there turn the energy of coal into electricity to be carried off to where power, heat and light are needed, by wire.

TON-MILE STATISTICS OF SWITCHING LOCOMOTIVES.

COMMITTEE—C. H. QUEREAU, G. R. HENDERSON, G. L. FOWLER.

EDITOR'S NOTE.—This report contains a reprint of a mileage record of switching locomotives taken for the *Railroad Gazette* by Mr. George L. Fowler, and concludes with the following observations:

In view of the care with which these records were taken, the length of time covered in each case and the fairly close agreement of the several records, it seems fair to conclude that the results agree reasonably with the facts. On this basis, three miles an hour for switch engines doing freight work and three and one-half miles an hour for passenger switch engines appear to be a fair credit. If we had equally reliable data as to the average tonnage handled, a comparatively accurate credit of ton-mileage could be proposed, but inasmuch as we know of no such records and the credit would be an arbitrary one, we have thought best to make no recommendation.

MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-SEVENTH ANNUAL CONVENTION.

ABSTRACT OF REPORTS.—CONTINUED.

CAST-IRON WHEELS.

COMMITTEE—WM. GARSTANG, W. H. LEWIS, WM. APPS, J. J. HENNESSEY.

It will be the intention in this report to eliminate all special or individual conditions and recommend for your consideration what seemed to your committee best to cover the conditions as they now exist. While the time may be ripe for experiments and research along new lines of design and manufacture, the question is certainly too important for this committee to recommend any radical changes without making an expensive series of tests extending over several years and it is the opinion of your committee that experiments of this kind should be carried out solely by the individual members rather than assigned to committee. There were submitted to the committee some twenty different designs of wheels for 60,000, 80,000 and 100,000-lb. cars that were recommended by the wheelmakers or the roads using them, as giving satisfactory service and of which there was no special complaint to be made. After these wheel drawings were made full size on cardboard and cut out, it was surprising to see the difference in contour of the

plates. This naturally raised the question, if the exact lines of plates were of any vital importance or had any effect on the life or wearing qualities of the wheel, and in the opinion of your committee it does not. The subject being interesting and to see what a composite wheel made from all of these good designs would look like, the wheels were grouped and those having the nearest lines plotted one over the other and a composite drawing made. These drawings were again plotted and a representative wheel worked out from them. These final wheels are shown by drawings 1, 2 and 3, and while they might not give any better satisfaction than any of the designs from which they were made they certainly make a very handsome looking wheel and in the opinion of your committee would make a wheel at least equal to the best design now in use and one safe to be followed in making new patterns. These drawings do not show the composite lines for thickness through the throat, or hub lines, of the wheels submitted, but show these lines as recommended by the committee for adoption.

Your committee has gone into the matter of design without being able to come to any conclusion that would justify a reduction in weight without an improvement in the quality of metal used, and the question of quality of material to be used seems to be one that it is absolutely impossible for your committee or those roads not manufacturing their own wheels to control. As mentioned earlier in this report, the special cases where wheels are manufactured at home cannot be taken as a basis for the vast majority, who have to secure their wheels in the open market. Especially is this the case when the wheelmakers advise that any special brand or make of iron that should be specified would only result in a radical increase of price without a corresponding increase in the guarantee. Your committee also believes that a specification of this kind would result in very serious delays and a final acceptance of wheels made of such iron as the manufacturer could secure of grades he has been accustomed to use and which he is willing to guarantee. Therefore the only recommendation governing this point is one limiting the per cent. of scrap to new iron used.

For the reason given your committee recommends the following weights of wheels:

For cars of 60,000 lbs. capacity, 600 lbs.
For cars of 80,000 lbs. capacity, 650 lbs.
For cars of 100,000 lbs. capacity, 700 lbs.

With a minimum weight allowed in interchange of 580, 630 and 680 lbs. and further recommend that all wheels cast in the future have their normal weight cast on the outside plate in figures not less than 1¼ in. long and ⅛ in. high.

It is the further recommendation of your committee that the present wheel specifications be changed to include the weights adopted for wheels for 60,000, 80,000 and 100,000-lb. cars; that they require the normal weight of the wheel cast on the plate in letters not less than 1¼ ins. long; that the amount of old wheels allowed in mixture be not more than 60 per cent. of the total charge. That the chill be not less than ½ in. or more than 1 in. in the tread or throat.

That the drop test be changed to make the test a failure if the wheel cracks, checks or breaks, in the flange, rib or plate, and that the test shall be ten blows of the 140-lb. weight falling 12 ft. for 600-lb. wheels or wheels for 60,000-lb. cars; 13 ft. for 650-lb. wheels or wheels for 80,000 lb. cars, and 14 ft. for 700-lb. wheels or wheels for 100,000-lb. cars.

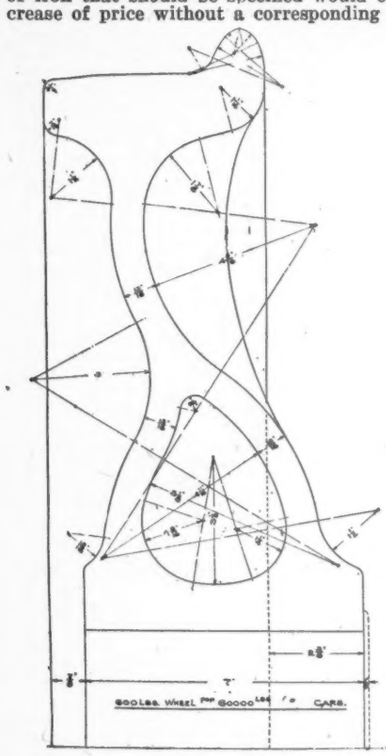


FIG. 1.

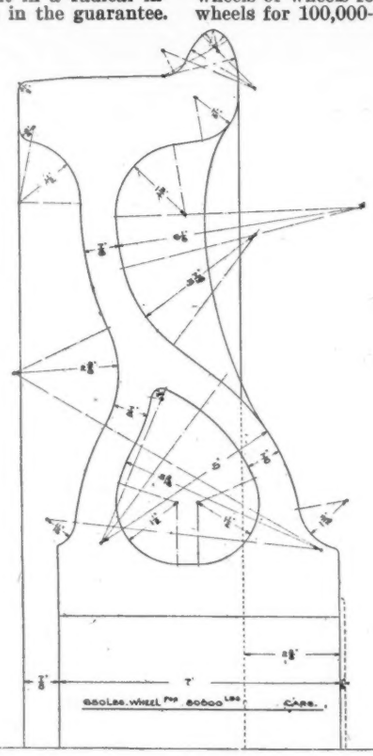


FIG. 2.

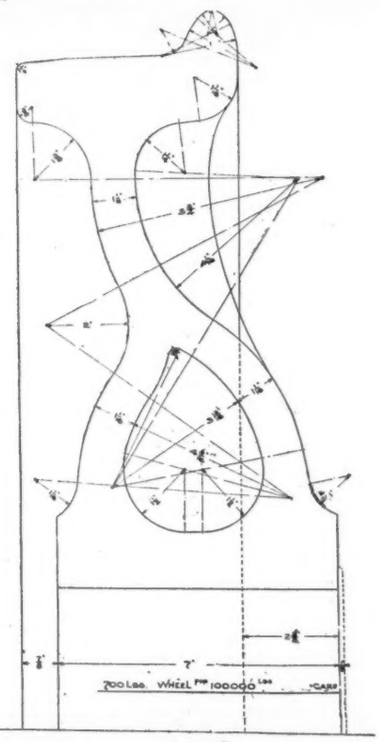


FIG. 3.

STANDARD REQUIREMENTS FOR HIGH-SPEED FOUNDATION BRAKE GEAR FOR PASSENGER SERVICE.

COMMITTEE—F. M. WHYTE, F. H. CLARK, R. N. DURBOROW, J. W. LUTTREL, C. A. SCHROYER.

The Hodge system of levers is shown in the diagrams, and the levers, rods and other parts are calculated for this system; if some other system of levers is used, it is recommended that the calculations be based upon the fundamental data which are given below. The designs have been submitted to the important air-brake manufacturers and have received the endorsements of such manufacturers.

FUNDAMENTALS.

Following are the fundamentals of the design:

Braking power to be 90 per cent. of the light weight of the car.
Equalized pressure in brake cylinder, 60 lbs. per square inch.
Maximum pressure in brake cylinder, 85 lbs. per square inch.
Maximum stress in levers, 23,000 lbs. per square inch.
Maximum stress in rods, except jaws, 15,000 lbs. per square inch; no rod to be less than ⅞ in. in diameter.
Maximum stress in jaws, 10,000 lbs. per square inch.
Maximum shear on pins, 10,000 lbs. per square inch.
Diameter of pins to provide a bearing value not to exceed 23,000 lbs. per square inch.

The reduction of stresses in rods, levers and jaws due to friction of the foundation brake, and the reduction of braking power due to the same cause and to the action of release springs, were neglected because it was considered to be too difficult to determine their value even with a fair degree of accuracy.

SIX-WHEEL TRUCKS.

The committee did not know the weight of the lightest car carried on six-wheel trucks nor the weight of the heaviest, therefore it was assumed that if cars weighing 80,000 lbs. to 137,000 lbs. were properly provided for then the actual limits of weight would be provided for very satisfactorily. The higher limit of 137,000 lbs. was decided upon because certain pins and other parts would need to be increased in diameter in order to fulfil, for heavier cars, the fundamental conditions prescribed in the foregoing. The brake rigging designed for the cars having six-wheel trucks can be used to brake a car weighing 137,000 lbs. to 87.5 per cent. without exceeding the maximum stress prescribed.

The committee submit schedule "A-1" for cars weighing 80,000 to 100,000 lbs. and schedule "A" for cars weighing 100,000 to 137,000 lbs. and having six-wheel trucks; the difference between these schedules is that a 16-in. brake cylinder is to be used for schedule "A" and a 14-in. brake cylinder is to be used for schedule "A-1," otherwise they are the same. The location of the fulcrum hole in the cylinder lever is made to vary by quarters of an inch to suit the weight of the cars, but only one fulcrum hole shall be drilled in each lever.

With schedule "A" there should be used a brake beam suitable for a load of 28,000 lbs., and with schedule "A-1" there should be used a brake beam suitable for a load of 22,000 lbs. imposed at the middle of the beam.

Before deciding to recommend a uniform size of levers, rods and pins for all cars with six-wheel trucks and weighing from 80,000 to 137,000 lbs. there were laid out two brake riggings in accordance with the fundamental data decided upon. One rigging was designed for cars weighing from 80,000 to 100,000 lbs. and the other for cars weighing from 100,000 to 133,000 lbs. and the weights of the parts for each were calculated. It was found that the difference in the weights for the body parts was 57½ lbs. and the difference in weights of parts for two trucks was 67 lbs., a total of 124½ lbs. for one car. It was considered that economy would result from the use of one set of levers, rods, jaws and pins for

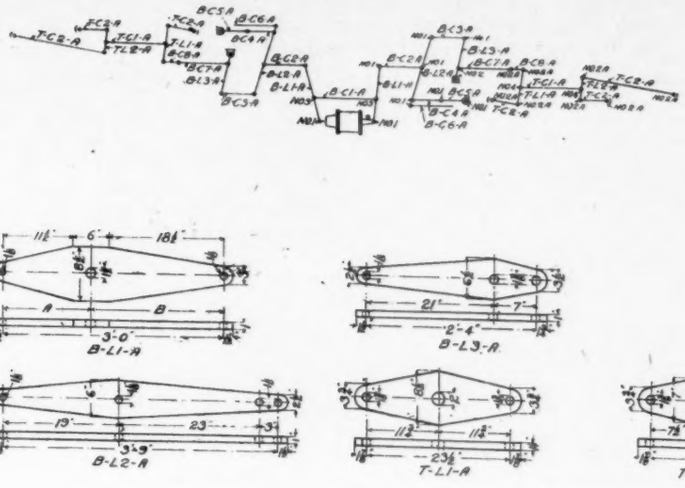


TABLE I
SCHEDULE H-1
FOR CARS WEIGHING 80,000 TO 137,000 LBS.

14" BRAKE CYLINDER CYLINDER LEVER B-L1-A				
FOR CARS WEIGHING	% BRAKE POWER PER CYL. PRES. PER SQ. IN.	LEVER NO.	A	B
		1	13"	23"
78,500 to 80,800	90 to 87.5	2	13½	22½
80,900 to 83,200	90 to 87.5	3	13½	22½
83,300 to 85,700	90 to 87.5	4	13½	22½
85,800 to 88,300	90 to 87.5	5	14"	22"
88,400 to 90,900	90 to 87.5	6	14½	21½
91,000 to 93,500	90 to 87.5	7	14½	21½
93,600 to 96,200	90 to 87.6	8	14½	21½
96,300 to 99,000	90 to 87.5	9	15	21
99,100 to 101,900	90 to 87.5	10	15½	20½
		11	15⅝	20½

TABLE II
SCHEDULE H
FOR CARS WEIGHING 100,000 TO 137,000 LBS.

16" BRAKE CYLINDER CYLINDER LEVER B-L1-A				
FOR CARS WEIGHING	% BRAKE POWER PER CYL. PRES. PER SQ. IN.	LEVER NO.	A	B
99,000 TO 102,500	90 to 87.5	1	13"	23"
102,600 to 105,600	90 to 87.5	2	13½	22½
105,700 to 108,700	90 to 87.5	3	13½	22½
108,800 to 112,000	90 to 87.5	4	13½	22½
112,100 to 115,500	90 to 87.5	5	14"	22"
115,600 to 119,100	90 to 87.5	6	14½	21½
119,200 to 122,800	90 to 87.5	7	14½	21½
122,900 to 125,700	90 to 87.5	8	14½	21½
125,800 to 129,400	90 to 87.5	9	15"	21"
129,500 to 133,000	90 to 87.5	10	15½	20½
133,200 to 137,000	90 to 87.5	11	15⅝	20½

FOUNDATION BRAKE FOR PASSENGER CARS, WITH HIGH-SPEED BRAKES. SCHEDULES A AND A-1.
CARS WEIGHING 80,000 TO 137,000 LBS. 6-WHEEL TRUCKS.

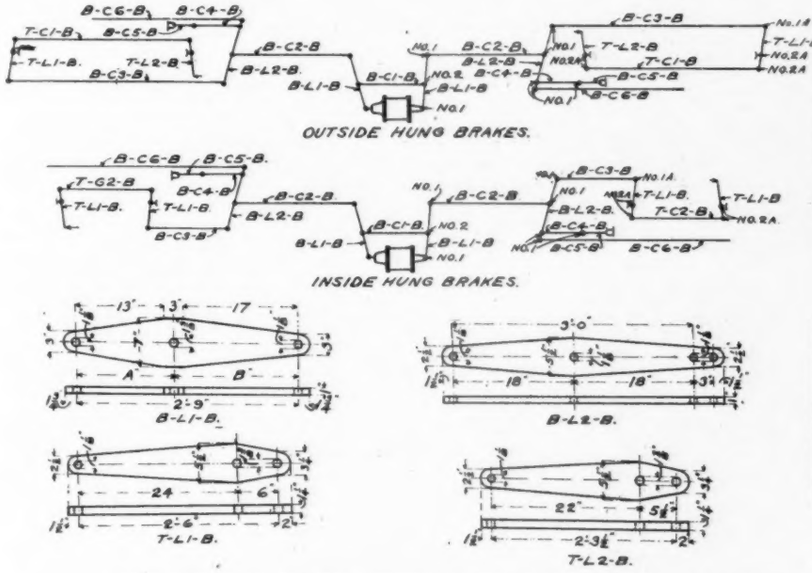


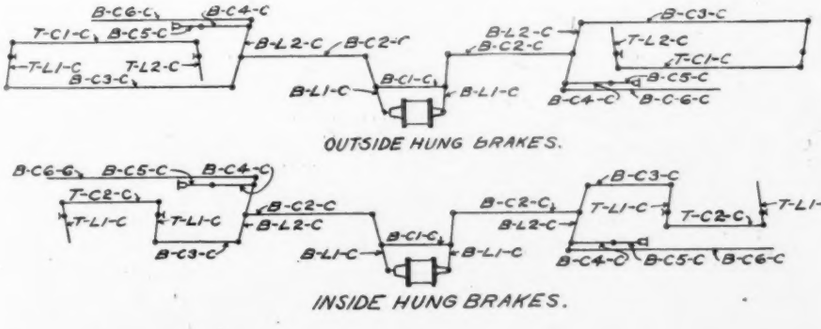
TABLE I
SCHEDULE B-1
FOR CARS WEIGHING 50,000 TO 70,000 LBS.

12" BRAKE CYLINDER CYLINDER LEVER B-L1-B.				
FOR CARS WEIGHING	% BRAKE POWER PER CYL. PRES. PER SQ. IN.	LEVER NO.	A.	B.
49,000 TO 50,500	90 TO 87.5	1	13"	20"
50,600 TO 52,400	90 TO 87.5	2	13½	19½
52,200 TO 53,700	90 TO 87.5	3	13½	19½
53,800 TO 55,300	90 TO 87.6	4	13½	19½
55,400 TO 57,000	90 TO 87.4	5	14"	19"
57,300 TO 59,000	90 TO 87.4	6	14½	18½
59,100 TO 60,800	89.8 TO 87.5	7	14½	18½
60,900 TO 62,700	90 TO 87.5	8	14½	18½
62,800 TO 64,600	90 TO 87.5	9	15"	18"
64,700 TO 66,700	90 TO 87.4	10	15½	17½
66,800 TO 68,700	90 TO 87.5	11	15½	17½
68,800 TO 70,800	90 TO 87.5	12	15½	17½

TABLE II
SCHEDULE B
FOR CARS WEIGHING 70,000 TO 90,000 LBS.

14" BRAKE CYLINDER CYLINDER LEVER B-L1-B.				
FOR CARS WEIGHING:	% BRAKE POWER PER CYL. PRES. PER SQ. IN.	LEVER NO.	A	B.
		1	13"	20"
68,800 TO 70,900	90.0 TO 87.4	2	13½	19½
71,000 TO 73,200	90.0 TO 87.4	3	13½	19½
73,300 TO 75,500	90.0 TO 87.5	4	13½	19½
75,600 TO 77,900	90.0 TO 87.4	5	14"	19"
78,000 TO 80,300	90.0 TO 87.4	6	14½	18½
80,400 TO 82,800	90.0 TO 87.4	7	14½	18½
82,900 TO 85,400	90.0 TO 87.4	8	14½	18½
85,500 TO 88,000	90.0 TO 87.5	9	15"	18"
88,100 TO 90,800	90.0 TO 87.4	10	15½	17½

FOUNDATION BRAKE FOR PASSENGER CARS, WITH HIGH-SPEED BRAKES. SCHEDULES B AND B-1.
CARS WEIGHING 50,000 TO 90,000 LBS. 4-WHEEL TRUCKS.



SCHEDULE C.
FOR CARS WEIGHING 39,000 TO 50,000 LBS.

10" BRAKE CYLINDER CYLINDER LEVER B-L1-C.				
FOR CARS WEIGHING:	% BRAKE POWER PER CYL. PRES. PER SQ. IN.	LEVER NO.	A	B
38,600 TO 39,700	89.9 TO 87.2	1	14"	19"
39,800 TO 40,900	90.0 TO 87.6	2	14½	18½
41,000 TO 42,200	90.1 TO 87.5	3	14½	18½
42,300 TO 43,500	90.0 TO 87.5	4	14½	18½
43,600 TO 44,900	90.1 TO 87.6	5	15"	18"
45,000 TO 46,300	89.9 TO 87.4	6	15½	17½
46,400 TO 47,700	89.9 TO 87.5	7	15½	17½
47,800 TO 50,000	90.0 TO 87.6	8	15½	17½

FOUNDATION BRAKE FOR PASSENGER CARS, WITH HIGH-SPEED BRAKES. SCHEDULE C.
CARS WEIGHING LESS THAN 50,000 LBS. 4-WHEEL TRUCKS.

all cars having six-wheel trucks and weighing from 80,000 to 137,000 lbs. instead of using two sets of levers, rods, jaws and pins for such cars, and the recommendations correspond with this idea.

FOUR-WHEEL TRUCKS.

The greatest weight of cars equipped with four-wheel trucks was taken as 90,000 lbs. As for the cars having six-wheel trucks, two brake riggings were first designed, one for cars weighing from 50,000 to 70,000 lbs., and one for cars weighing from 70,000 to 88,000 lbs., and the differences in weights of parts were, for body parts 35 lbs., and for parts for two trucks 42 lbs., a total of 77 lbs. Therefore it was considered desirable to recommend one system of levers, rods, jaws and pins for all cars weighing from 50,000 to 90,000 lbs. and having four-wheel trucks.

The brake designed for cars weighing 88,000 lbs. can be used to brake a car weighing 90,800 lbs. to 87.4 per cent. without exceeding the maximum stresses prescribed.

Schedule "B-1" is for cars weighing 50,000 to 70,000 lbs. and having four-wheel trucks, and schedule "B" is for cars weighing from 70,000 to 90,000 lbs. and having four-wheel trucks, the differences between the two being that a 14-in. brake cylinder is to be used with schedule "B," cars weighing 70,000 to 90,00 lbs., and a 12-in. brake cylinder is to be used with schedule "B-1," cars weighing 50,000 to 70,000 lbs.; also that with schedule "B" there should be used a brake beam suitable for a load at the middle of 28,000 lbs., the same as for schedule "A," and with schedule "B-1" there should be used a brake beam suitable for a load at the middle of 22,000 lbs., the same as for schedule "A-1."

The proper braking power for the weight of car is obtained by the location of fulcrum hole in the cylinder lever.

Schedule "C" needs only a few words of explanation. It was designed for cars weighing 50,000 lbs. and less, equipped with four-wheel trucks. A 10-in. brake cylinder is to be used with this schedule and a brake beam suitable for a load at the middle of 15,200 lbs.

PINS AND ROD JAWS.

For all the schedules suggested there be required a total of eight different pins; one of the pins is a present M. C. B. Standard. Of the eight there are four different diameters. The pins are numbered. There are ten different rod jaws required for all the schedules and these are made of four different sizes of iron.

DESIGNATION OF RODS AND LEVERS.

On the drawings, the location of levers and rods are designated by letters, the first letter in the designation distinguishes between body and truck. The second letter distinguishes between the levers and the connections. The figure following the second letter is the distinctive number for the lever or connection; and following this figure is the schedule letter to which the lever or connection belongs. Thus B-C2-B means body connection number two (second from cylinder piston rod), of schedule "B"; also T-L2-B would mean truck lever number two for schedule "B."

TABLE I.

Schedule designation.	Light weights of cars. (Lbs.)	Type of truck.	Size of brake cylinder.	Maximum load at middle of brake beam.
A.	100,000 to 137,000	6-wheel	16 ins.	28,000 lbs.
A-1.	80,000 to 100,000	6-wheel	14 ins.	22,000 lbs.
B.	70,000 to 90,000	4-wheel	14 ins.	28,000 lbs.
B-1.	50,000 to 70,000	4-wheel	12 ins.	22,000 lbs.
C.	50,000 and less.	4-wheel	10 ins.	15,200 lbs.

There have been brought together in Table I. the distinctive data of each schedule so that by referring to the table the correct schedule for any particular car may be found quickly.

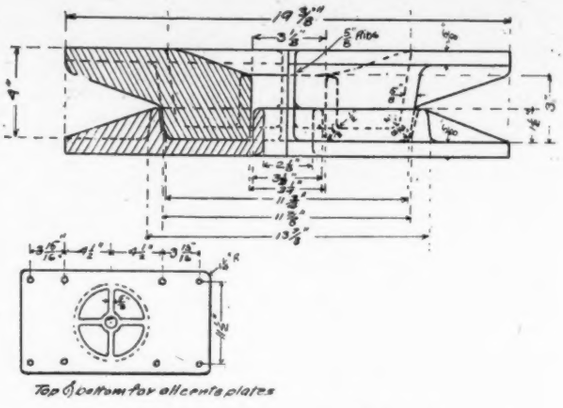
SIDE BEARINGS AND CENTER PLATES.

Committee—T. W. Demarest, A. E. Benson, J. W. Luttrell, G. N. Dow.

In summing up the results obtained, the minimum flange resistance was obtained with the flat plate, "Form A," of chilled cast iron. The projected area of this plate was 100.14 sq. ins. In order to determine the best size of this plate, six different plates were constructed, ranging in area from 100.14 sq. ins. to 46.793 sq. ins. The results obtained, as noted in the tables and on the cards, are so close that it is difficult to say which will be the best area to adopt. Apparently, the flat plate with an area of 86.738 sq. ins., using as a basis a smooth casting, no lubrication, gave the best general results, and a flat plate of this description is recommended to the association as the standard form of center plate.

It will be noted also that two ball bearing center plates were tried. These center plates gave such remarkable results that there can be no question of a reduction in flange resistance by their use. One road has been using for a number of years now a ball bearing center plate, and in so far as durability is concerned, the plates are reported as giving entire satisfaction. It is recommended to the association that during the coming year the members equip a number of cars with ball bearing center plates, in order to ascertain more fully their durability.

A number of side bearings were also tried, but these experiments could not be completed, as, in order to test the different makes, it would have been necessary to reconstruct the machine, which time would not permit. In so far as the tests were carried out, however, the results indicate very much less flange resistance with the roller side bearings than with the ordinary flat cast iron plate. On account of the inability to thoroughly test out the side bearings, the recommended distance from center of center plate to center line of side bearing was not obtained. Replies from various members of



RECOMMENDED FORM OF CENTER PLATE.

the association indicate this distance to run from 24 to 32½ ins. In the tests as conducted the distance was taken as 25 ins.

While the committee recommends to the association a standard form of center plate, as Plate "A," there is no doubt in the minds of the committee that if the ball bearing center plates and side bearings are durable in service a very greatly decreased flange resistance will be obtained.

GOLD CAR HEATING & LIGHTING COMPANY.

The amount of Gold heating apparatus sold during the past year was nearly double that of any former year since the origin of this business. Not only has the tremendous increase taken place in its steam railway car heating department, but the electric heating branch has developed and improved very materially as well.

The trade of this company is increasing continually. During the past three months the number of cars and locomotives for which orders for heating equipment have been received has been very gratifying. Among others, it is interesting to note that a few of the orders recently taken by the Gold Company for cars, locomotive and electric car heating equipment are as follows:

	Equipments.
Canadian Pacific	290
Brooklyn Heights Railroad	240
Missouri Pacific	125
Wabash	105
Erie	102
New York, New Haven & Hartford	101
Massachusetts Electric Companies	100
Metropolitan Street Railway	100
Southern	79
Louisville Railway	75
Central Railroad of New Jersey	58
New York Central & Hudson River	45
New Orleans & Northeastern	40
Boston & Albany	37
Cleveland, Cincinnati, Chicago & St. Louis	36
Denver & Rio Grande	35
Chicago & Eastern Illinois	32
Western Maryland	21
South Side Elevated	20
Scranton Railway	15
Nashville, Chattanooga & St. Louis	21
M., St. P. & S. S. M.	22
Cincinnati, Hamilton & Dayton	12
Texas & Pacific	24
Georgia Railroad	4
Lake Shore & Michigan Southern	15
Boston & Maine	28
New York, Ontario & Western	14
Delaware, Lackawanna & Western	25
Chesapeake & Ohio	5
Atlanta & West Point	6
Central of Georgia	14
Alabama Great Southern	4
Cincinnati, New Orleans & Texas Pacific	14
Vicksburg, Shreveport & Pacific	8
Alabama & Vicksburg	6
Mobile & Ohio	15
Louisville & Nashville	3

The above are but a few of the many contracts received within the last few months. As a matter of fact, during the short period mentioned the company has sold nearly 4,000 sets of its heating equipment in the United States alone. During the past month an order has also been received for the shipment of several thousand sets of its specialties abroad.

A short time ago a contract was closed with the Atlantic Coast Line to cover the use of Gold Car Heating and Lighting Company's system on all of the passenger cars and locomotives of the Atlantic Coast Line, Plant System and the Charleston & Western Carolina.

Within the past few days the New York Central & Hudson River Railroad, together with the Lake Shore Railway, and the lines which they operate, decided to adopt the company's improved large size Gold straight port steam coupler for use on all of their cars and locomotives.

The unfilled contracts on the books of the Gold Company at the present time are larger than ever before in its history. At the last meeting of directors the regular quarterly dividend of 2 per cent., together with an extra dividend of 9 per cent., was declared. All of the company's devices have been improved from time to time, and in their latest systems many ingenious and valuable features are apparent and most highly commended. The very general adoption of its car, locomotive and electric heating apparatus all over the world where modern appliances of this kind are used, speaks volumes for the merit of the Improved Gold Systems of Car Heating. The main office of Gold Car Heating and Lighting Company is at Frankfort and Cliffs streets, New York City. The other offices of the company are at Chicago and London.

A STUDY OF ALLOYS FOR BEARING PURPOSES.

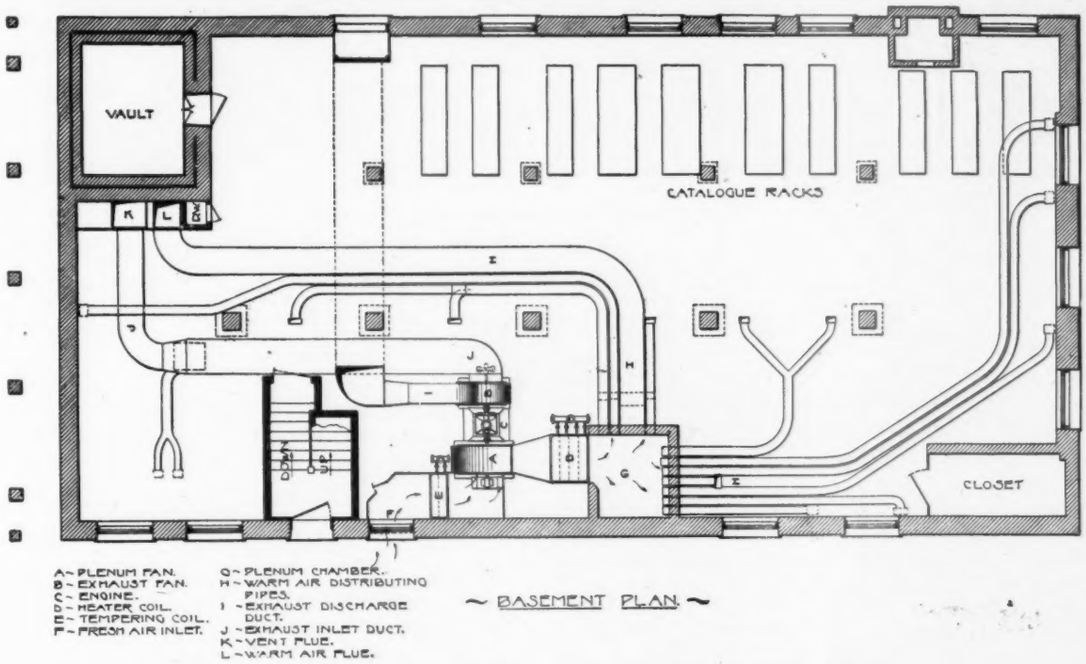
In an admirable paper on this subject read before the Franklin Institute, Mr. G. H. Clamer, of the Ajax Metal Company, Philadelphia, presented an interesting study of white metals and bronzes. He described tests, discussed various proportions of bronzes and showed how his investigations corroborated other well-known authorities. As a result of much experimenting a new alloy was developed, concerning which he made the important statements given below. Readers are referred to the paper itself for the complete discussion.

"This alloy is now known in the trade as 'Plastic Bronze,' and has become a thoroughly commercial article. It has been on the market hardly three years, but has been made in an amount which approximates 4,000,000 lbs. It has been cast in all manner of patterns, weighing from a fraction of a pound to over 1,000 lbs. each, and is handled as readily in the foundry as phosphor bronze, manganese bronze or any of the more common alloys. Castings are sharp and clean. It machines readily, and, in fact, possesses all the qualifications essential for practical purposes.

"Having accomplished the production of an alloy containing upwards of 20 per cent. lead, the next object was to test it in the manner of the previous ones, the tin being kept constant at 5 per cent.

"The alloy which we have adopted consistent with proper strength for general purposes and with the best foundry results is: Copper, 64 per cent.; tin, 5 per cent.; lead, 30 per cent., and nickel, 1 per cent.

"It will be noted that what is true of the alloys of 15 per cent. lead and under, as examined by Dr. Dudley, is also true of the high-lead-content alloys, viz: that the rate of wear diminishes with increase of lead, or, in other words, the rate of wear diminishes with the diminishing compressive strength or increased plasticity of the alloy. This alloy has plasticity resembling Babbitt metals, and for this reason can fairly be expected to show a less tendency to become heated. This has been amply proven in actual service."



VENTILATING AND HEATING SYSTEM.—OFFICES AMERICAN BLOWER COMPANY.

AMERICAN BLOWER COMPANY'S NEW OFFICE BUILDING.

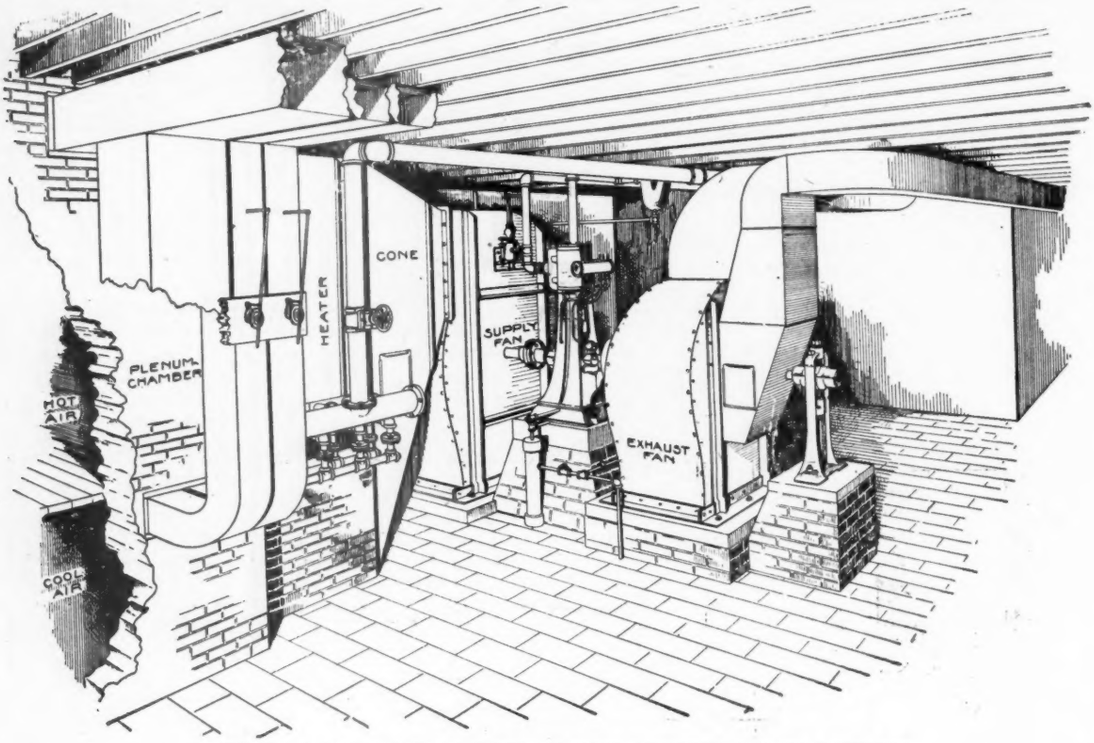
HEATING AND VENTILATING SYSTEM.

The accompanying cuts show the spacious new office building of the American Blower Company of Detroit, Mich. The business of this company has increased so rapidly during the last two years that the old offices, which occupied valuable space in one of the factory buildings, became entirely inadequate to accommodate the increased office force.

The first floor is occupied entirely by the different commercial departments, while the second floor is used by the engineering and drafting departments. The basement is used for the storage of catalogues, letter files, etc. The blue-print and dark room are provided for on the roof, being located in that position to secure the best light for sun printing.

The main interest in the equipment of this building is in the mechanical system of heating and ventilating. As the manufacture of heating and ventilating apparatus forms a large part of the American Blower Company's business, this part of the office equipment naturally received due attention. The apparatus is located at one side of the basement as shown on the accompanying plan. The fresh air enters the building through the basement window F and by means of the fan A is drawn over a coil of pipes, E, called the tempering coil. The steam pipes in this tempering coil are just sufficient in number and length to heat the volume of entering air to a temperature of 65 or 70 degs. The fresh air is then drawn into the fan and forced over another heater, D. This is the main heater and is designed to heat the air to about 140 degs. Beyond the heater is located a large brick chamber, C, called the plenum chamber. This serves as a reservoir for the heated air, and from this chamber the air is conveyed by galvanized iron pipes, H, to the various offices. Under the main heater, D, is a passage or by-pass, as it is called, which permits a part of the air from the fan to pass under the main heater coil and into the plenum chamber. This passes into the lower section

of the plenum chamber, which is separated from the upper part. Thus the plenum chamber is divided into two parts, as shown by accompanying sectional elevation, the upper chamber containing hot air at approximately 140 degs. and the lower section tempered air at 70 degs. As shown by this sectional view, each individual pipe leading off to the offices above has two connections to this plenum chamber, one branch to the upper section and another to the lower. In each main where the pipe divides into these two sections there is located



VENTILATING AND HEATING SYSTEM.—OFFICES AMERICAN BLOWER COMPANY.

a set of double swinging dampers, or mixing dampers. Each set of these dampers is controlled automatically by a diaphragm valve shown on the outside of the pipe in the sectional view. These automatic valves are part of a system of automatic heat control which was furnished by the Johnson Electric Service Company, of Milwaukee, Wis. These valves are operated by compressed air, which is supplied by a small air compressor located in the basement. This compressor works by city water pressure and delivers air at about 15 lbs. pressure. On the expansion or contraction of a piece of brass and steel in the thermostat, air pressure is admitted or cut off from the diaphragm valve and the mixing dampers are swung one way or the other, as the case may be. It will be noted that these mixing dampers in swinging do not cut off the flow of air, but simply vary the proportion of hot and tempered air as controlled by the thermostat to maintain a constant temperature in the room. Thus a constant flow of pure air of the proper temperature is maintained at all times. Under the tempering coil there is also a by-pass similar to the one under the main heater. This by-pass is fitted with a swinging damper, which is controlled by a thermostat placed in the upper part of the plenum chamber. Thus if the air in the plenum chamber becomes too hot, the thermostat opens the damper under the tempering coil and allows the entering air to pass under the tempering coil instead of through it. The air is admitted to each room at a point of about 8 ft. above the floor.

The fan is operated by a direct-connected vertical engine. This engine is also the American Blower Company's own make and is specially designed for this class of work. Another unique feature of this plant is the exhaust fan, which is direct-coupled to the same engine which runs the heating fan and which draws the impure or vitiated air out of the building. Thus while one fan is discharging pure warm air into the building the other fan on the same shaft is drawing out the impure air. This is the main feature of mechanical ventilation which has brought it into such general favor during the last few years for use in public buildings.

The condensation from the heating apparatus is returned to a Webster feed-water heater located in the engine room of the factory. This same system handles all the condensation from two other heating plants located in the factory. The advantage of this vacuum system is that it eliminates the back pressure from the factory engine when using exhaust steam for heating and also removes the air from the heating coils and connecting pipes as fast as it accumulates, thus making the heating surface far more effective than it otherwise would be.

MOGUL METAL.

The T. H. Symington Company use a metal for their journal boxes, of which a description has been received which is condensed as follows:

The crystalline structure, heat treatment and condition of the carbon content are factors of the greatest moment in iron and steel. In a long period of experimental work this company has sought a metal which would have sufficient density, close crystalline structure, high resilience and at the same time maintain the fine wearing qualities of cast iron "which are noticeably absent in malleable iron. The results obtained are so wonderful and far-reaching that we have practically produced a new metal, which we have named 'Mogul Metal,' which has all of the above desired characteristics and is an absolutely certain obtainable product."

"Ferrite" is practically pure iron and, except graphite, is the softest constituent of cast iron products. Ferrite is iron practically free from carbon, though it may contain other impurities. Fig. 1 illustrates the appearance of ferrite as it would appear under a powerful microscope, the lines representing the divisions into crystals. "Cementite" is the hardest constituent of iron or steel and is a definite carbide of iron. It does not occur by itself, but is found in thin layers which are straight or curved and alternating with thin layers of fer-

rite. These layers together are known as "pearlite." With the first increment of carbon in wrought iron pearlite forms in the corners or angles of the crystals and has the form indicated in Fig. 2. With about 0.8 per cent of carbon the pearlite has the appearance of Fig. 3. With more carbon than this the free cementite appears as shown in Fig. 4, and as it increases the free cementite entirely surrounds the crystals and the pearlite becomes immersed in free cementite. The carbon which exists in the mass as free cementite and pearlite may be entirely changed by heat treatment into the form of small particles of free carbon uniformly distributed throughout the mass of ferrite which is simultaneously formed and is illustrated by Fig. 5. In this form the carbon known as "temper

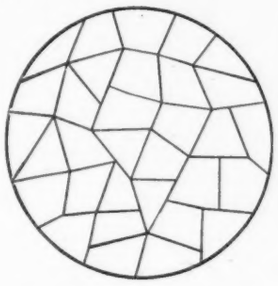


Figure One—Ferrite crystals containing no carbon.

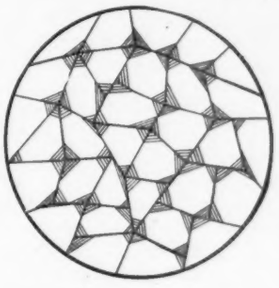


Figure Two—Ferrite crystals with less than .8 per cent. carbon in form of Pearlite.

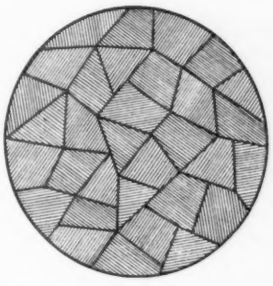


Figure Three—Iron with carbon about .8 per cent., all in form of Pearlite.

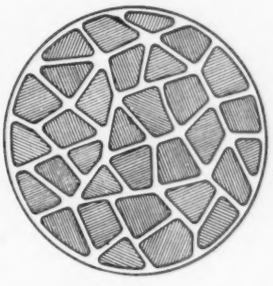


Figure Four—Iron with carbon in excess of .8 per cent., showing Pearlite and free Cementite.

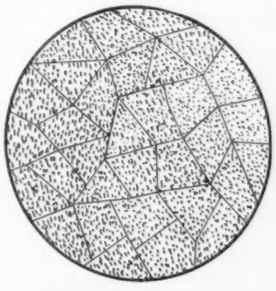


Figure Five—Iron in which Pearlite and free Cementite has been broken up by heat treatment into the form of Temper Carbon.

Figure Six—Iron in which Pearlite and free Cementite has been broken up by heat treatment into Temper Carbon, also showing the manner in which Graphitic Carbon exists throughout the mass in cast iron.

DIAGRAMS REPRESENTING STRUCTURE OF CAST IRON.

carbon" exists in minute holes in the ferrite crystals and does not destroy the ductility of the ferrite. This structure is somewhat similar to common commercial malleable iron. The way graphite exists in iron is illustrated in Fig. 6, where the black irregular portions are graphite imbedded in metal in which combined carbon or cementite has been, by heat treatment, thrown into the uniformly distributed temper carbon as illustrated in Fig. 5. "Our great aim is, as far as possible, to control the size of the particles of graphite carbon. To produce the desired structure we must absolutely control the amount and size of graphite carbon in our casting."

What is sought in "Mogul Metal" is wearing qualities superior to the best gray iron, and far superior to malleable iron. The control mentioned is obtained by a special mixture and by the use of ingredients found to have a remarkable and peculiar effect on the graphite and other elements, phosphorus, silicon, sulphur and manganese, and, further, by the heat treatment. Having developed this process, this company uses this metal with "certainty that it will meet the demands of hard railroad usage. The metal has about the same tensile strength as good malleable iron, but is not quite so ductile. It can be slightly bent, but cannot be mashed out of shape without breaking." This new metal is advocated because it will hold its shape and, furthermore, it has a high scrap value, and its weight is about the same as malleable iron. The general offices of the T. H. Symington Company are in the Calvert Building, Baltimore, Md.

Mr. Norton A. Mears has been appointed storekeeper of the Indiana, Illinois & Iowa Railroad at Kankakee, Ill.

BOOKS AND PAMPHLETS.

The Car Builders' Dictionary, 1903. An Illustrated Vocabulary of Terms Which Designate American Railroad Cars, Their Parts, Attachments and Details of Construction. Compiled for the Master Car Builders' Association by Rodney Hitt. Illustrated, bound in leather. Published by the *Railroad Gazette*, 83 Fulton street, New York. Price, $5.00.

The first edition of this indispensable book was published in 1879, the second edition appeared in 1884, the third in 1895, and the present volume surpasses the others in every respect. It not only brings the subject up to date, but its general character in every particular is notably better. The standard of the present volume will be difficult to improve upon. The original purpose was to standardize the terms of car construction. This has given the work a powerful influence in the actual standardization of construction itself, so that the consummation of a standard car seems to be a possibility. It is to be hoped that the next edition will contain detail drawings of a standard car. The present volume gives evidence of most intelligent selection of subjects for illustration. The general plan of arrangement is not changed, but there are fewer engravings. The value of the book is increased by this, because only construction of proved merit and approved practice is included. Steel cars and improved draft gears naturally occupy a large amount of space. These have come into prominence since the appearance of the previous volume, and the treatment accorded them is a record of progress in new lines. By use of half-tones and line engravings, photographic views, floor plans, framing plans and sections of wooden and steel cars are shown in sufficient numbers to cover all requirements of reference, and the details of car furnishings and equipment are presented in a great variety. The book is not disappointing in any particular. Special mention should be made of the uniformly excellent line engravings. Our readers, being familiar with the earlier editions, will lose no time in securing copies of this one. Those who do not know the book need only be told that it affords a liberal education in the subject of cars and the standards of the M. C. B. Association. It is a pleasure for the reviewer to compliment the editor and publishers upon the satisfactory result of this difficult undertaking.

Railroad Construction: Theory and Practice. A Text-Book for the Use of Students in Colleges and Technical Schools. By Walter Loring Webb, C.E., Assoc. M., A. S. C. E., formerly assistant professor of civil engineering, University of Pennsylvania. Second edition, reset and enlarged. 675 pages. John Wiley & Son, 43 East Nineteenth street, New York. 1903. Price, $5.00.

The book in its revised edition is in pocket form and the material of the early edition is retained very largely in its original form, except in size of page. There are added, however, about 200 pages of new matter, which should make it of greater value for the purpose intended, as stated in the preface. "The author's aim has been to produce a text-book for students, and the subject matter has therefore been cut down to that which may properly be required of students in the time usually allotted to railroad work in a civil engineering curriculum." About 100 of the new pages treat of miscellaneous structures and buildings, yards and terminals, block signalling, rolling stock, train resistance, cost of railroads, the last of which is generally convenient and has especial value in connection with the treatment of the cost of items of

earthwork contained in the original book. Another 100 pages are devoted to railroad economics, treating of operating expenses and their effect upon changes in distance, curvature, rise and fall (although not so named), grades, ruling, pusher and balanced for unequal traffic, and the improvement of old lines. It is no discredit to Mr. Webb that he acknowledges closely following Wellington's treatment of the subject, for this seems yet the proper thing to do. The preface says: "Those who are familiar with the late Mr. Wellington's masterpiece, 'The Economic Theory of Railroad Location,' will readily appreciate the author's indebtedness to that work. The author has developed the theory on an independent basis, with the exception of a few minor details." It is not improbable that many engineers in railroad practice will be glad to look into the subject through the 100 pages used here, rather than attempt the larger and much more difficult task of picking out what they need from a larger book. The book is bound in morocco with a flap. The typography of the thirteen tables included is very good, and the book in its new dress is more useful for the people who would use it and is attractive in appearance generally.

Notes on Track Construction and Maintenance. By W. M. Camp, editor *Railway and Engineering Review*. 1,214 pages; 620 engravings. Published by the author at Auburn Park, Chicago, Ill. Price, $3.00. Printed in two volumes for foreign distribution; price, $3.50.

This is the most complete and comprehensive book ever written on the subject of track. The object of the author was to write simply enough for trackmen and thoroughly enough for engineers. The work was done with extraordinary care and conscientious patience, with the intention of bringing the entire subject up to date with particular reference to satisfactory construction and labor-saving machinery employed in track and road building. The author is a master of his subject, having been a trackman and afterward an educated engineer. In such a work the personal opinions of the author may not agree with those of all his readers, but these are set forth in this case as those of a man who has worked his way through all the grades of the track department. Mr. Camp does not hesitate to take issue with the report of the Master Mechanics' Association committee of 1900 on the subject of flanges on driving wheels, and, among other parts of the book, this will specially interest mechanical officers. The author's comments on this subject direct attention to the need of more co-operation between the various departments interested in such a subject as this, because there are many matters of this kind which affect both track and rolling stock. Some portions of the book seem to be unnecessary repetitions of the work of others—such as problems in switch work and curves. These, however, are probably included for the benefit of those who may not be supplied with hand-books on these subjects. The chapters are as follows: Track Foundation, Track Materials, Track Laying, Ballasting, Curves, Switching Arrangements and Appliances, Track Maintenance, Double Tracking, Track Tools, Work Trains, Miscellaneous, Organization and Supplementary Notes and Tables. It is a very valuable book on a most important subject and is treated from the standpoint of one who knows the difficulties which a so-called practical man must face in the pursuit of information and who also knows the difficulties which the engineer faces in his use of information which he has. The work was brought out serially in the *Railway and Engineering Review*, appearing in 154 articles. They have been revised, 80 of them being re-written, the book having 70 per cent. more reading matter added to the original. It is a book which every railroad officer in the operating, maintenance of way and mechanical departments should own and use.

Proportions and Movement of Slide Valves. By W. D. Wansbrough. 1903. D. Van Nostrand Co., Warren street, New York.

This volume of 160 pages contains in convenient form the articles by the author on this subject which have appeared serially in the pages of the *Mechanical World*. The author gives the credit for the invention of the slide valve to Murdoch, the pupil and assistant of Watt. The book opens with a number of studies of the functions of valves. The other chapters discuss double slide valves, expansion plates, and Meyer gear. Liberal use is made of valve diagrams. The book should be valuable to the designers of stationary engines.

Proceedings of the American Railway Association from 1899 to 1902, inclusive. Published by the association, 32 Park Place, New York. Price $5.

This is the third bound volume of the proceedings of this important organization, edited by the secretary, placing the reports and discussions in convenient form before those who desire to preserve this record. The index is unique in that it presents in the form of carefully prepared abstracts the most important work of the association. By referring to the index the busy reader will usually find all that he requires, and the text of the reports and discussions is easily found for complete reference. The book has over 1,000 pages. It is a large volume, and does not appear to have been abridged. It contains the semi-annual volumes which have been distributed in pamphlet form after each meeting of the association.

Metallic Packings. By Charles Longstreth. Reprint of a paper from the journal of the American Society of Naval Engineers, Vol. XV., No. 2.

Mr. Longstreth has conferred a favor upon engineers and users of metallic packing by this discussion of the principles of design essential for successful development of packing. The paper briefly discusses the early history of the subject, points out the purposes and requisites of satisfactory packing, and proceeds to present the characteristics necessary to meet the requirements of various kinds of service. Rigid and flexible forms are described, and special attention is given to the conical ring type of flexible packings which are in use on 90 per cent. of the locomotives running in the United States. It is made clear that engine efficiency is greatly dependent upon the character of packing used, and that most careful attention to efficient maintenance is absolutely necessary. By occasional references to locomotive practice as a field where maintenance is not all that could be desired, and by citing a record of ten years' service in marine practice, the author throws a side light upon a condition of the packing question on railroads which motive-power men would do well to consider most carefully. The paper shows the destructive effect of water on metallic packings and indicates the proper method of fitting up and maintaining them. Presumably copies of the paper may be had from Mr. Longstreth, 427 North Thirteenth street, Philadelphia.

Characteristic Facts About Trees.—How trees that are supposed to be familiar to everyone—like the pine and the oak—have beauties that are unnoticed by the ordinary observer will be shown, it is said, in some remarkable photographs taken by J. Horace McFarland to illustrate his forthcoming "Book of Trees." The author, besides being an ardent lover and an earnest student of nature, is an unusually expert photographer, and it is believed this work will show what is characteristic and beautiful about the trees as species and as individuals. The Outlook Company have the work in preparation, and believe that it will be ready by early fall.

Specifications for Material and Workmanship for Steel Structures.—The specifications adopted this year by the American Railway Maintenance of Way Association have been issued in pamphlet form. Copies may be had from the secretary, Mr. L. C. Fritch, room 1562, Monadnock Block, Chicago. Price 10 cents.

"Nature's Insulation" is the title of an exceptionally fine pamphlet issued by Messrs. Baeder, Adamson & Co., 730 Market street, Philadelphia, Pa., describing improved methods of insulation, using hair felt, for cold storage and other forms of refrigeration. The pamphlet was prepared by Mr. H. J. Bellman, who is in charge of the hair felt department of this company, and it is altogether the best work of the kind that we have seen. No one who is interested in the subject will lay the pamphlet aside without reading it clear through. It opens with a statement of the impossibility of perfect insulation and the reasons why nature's insulation, hair, is the best and most permanent material available. Hair owes its superior qualities to the air held mechanically by the fibers and retained motionless, "dead air" being the best non-conductor known. The second chapter deals with convection, conduction and radiation, illustrated by diagrams, and here is shown the importance of guarding against the destruction of the effectiveness of insulation by moisture. Proper stress is laid upon the fact that good insulation means a reduction of operating expense because poor insulation involves more refrigeration or more ice. Experience and investigation have taught the superior value of spaces filled with the right material over hollow construction confining air in spaces wherein it may move about. Results of experience and extensive experiments are given on page 23. It is shown that hair felt is twice as effective as mill shavings or mineral wool. This appears in the cost of construction and the space required for the insulation. This is very important in ship and car refrigeration. The descriptive por-

tion of the pamphlet closes with a statement concerning the manufacture of hair felt. It is made from selected cattle hair received direct from the tanners and thoroughly washed, picked and dried. Hair felt is put up an rolls of various widths and from ¼ to 2 ins. thick. Illustrations in colors show approved methods of application to refrigerators, cold storage spaces and refrigerator cars, also photographic reproductions of cars, cold storage warehouses and ships equipped with this insulation are included. This company has a record of seventy-five years in this product, which entitles them to thorough confidence.

The Watson-Stillman Co., 204 East Forty-third street, New York, issue catalogue literature in accordance with a unique and very convenient plan. The Illustrated Index for 1903, known as Catalogue No. 65, has just been received. Its purpose is to show in a medium-sized book the great variety of tools manufactured by this company. It is a pamphlet of 72 pages of illustrations, each engraving representing from one to twenty sizes of tools, and complete descriptions are available in the form of loose sheets. These sheets are bound in neat covers in various combinations to suit the demands of various correspondents, according to the special line of business for which hydraulic machinery is required. It would be impracticable to issue a single bound volume to include all, and the present scheme comprises seventeen sectional catalogues, of which eleven are in print and ready for issue, six being in manuscript or in unbound assortments. The index gives a key to all, and the one just issued replaces that of about four years ago. The present one has 72 pages of illustrations, being an increase of 28 pages, with additions in all departments. The pages are numbered, also the sheets giving detailed information, and it is easy for a purchaser to secure exactly the desired information. The pamphlet closes with an index of illustrated sheets. The engravings are all finely executed wood cuts. An examination of the pamphlet gives the impression of an extraordinary increase in the scope of hydraulic apparatus in manufacturing processes.

Two new circulars have been received from the Chicago Pneumatic Tool Company. These are advance sheets of a new catalogue. One is devoted to pneumatic drills. It illustrates Little Giant drills, flue-rolling, reaming, tapping, wood-boring machines and the Boyer piston air drill. A number of attachments for the drills are also shown, such as angle gears, flue cutters and flue expanders. The pamphlet closes with a statement of results of tests made with these machines, which illustrate their advantages over hand work. The other circular illustrates and describes pneumatic hammers and riveters. It includes valuable tables illustrating the possibilities of reducing the cost of work by their use. Such records are very seldom seen in catalogues. We have also just received special circulars Nos. 38 and 39, illustrating various types of pneumatic tools, with views of the tools at work. Special attention is directed to applications of the Boyer drill and "jam riveter," a new method for cleaning locomotive crown sheets with the riveter and of applying the Boyer drill to a yoke similar to those used in riveting. These are important functions of air tools believed to be entirely new, and are sure to find a good reception in locomotive shops.

"A Review of Technical Points for the Protection of Metal Surfaces" is the title of a pamphlet written by Mr. W. H. Loomis and issued by the National Paint Works, Williamsport, Pa. The author bases his opinion on an experience of twenty years, and the pamphlet contains references to many of the best known authorities on paints. The arguments in favor of oxide of iron paints include this: "The tin roof on old Independence Hall in Philadelphia, Pa., has been preserved for the past 130 years with an oxide of iron paint, which is conclusive argument for the pigments." Dr. C. B. Dudley, of the Pennsylvania Railroad, is quoted as follows: "We are quite free to confess that in our experience we have not been able to confirm the common belief among paint manufacturers, and indeed among many of the users, that the oil is the life of the paint. The *pigment* is the life of the paint, according to our experience." The pamphlet contains statements of great value to railroad men, and particularly to those who are anxious about the corrosion of steel cars. It contains numerous records of experience with paint on railroad structures.

Furguson Oil Furnaces.—A new catalogue has been issued by the Railway Materials Company, Old Colony Building, Chicago, illustrating these furnaces and showing their advantages for railroad shops and manufacturing plants. Opening with a brief statement of the peculiar adaptability of oil to heating furnaces and of the commercial savings made possible, the pamphlet presents excellent engravings, both from photographs and line drawings, illustrating fourteen styles of oil furnaces such as are used very successfully in the best and most modern railroad shops. These include small furnaces for flue welding and rivet heating, larger furnaces for forging and bulldozer work, for case-hardening spring work, and still larger ones for flanging and annealing of plates. The pamphlet closes with engravings of Furguson portable heaters and fire kindlers. In connection with the equipment of the Collinwood shops of the Lake Shore we shall refer to these furnaces again.

"Colors and Specifications" is the title of a handsome six-page folder issued by the Joseph Dixon Crucible Company, Jersey City, N. J. Five excellent examples of steel construction are illustrated. The specifications suggest best methods of construction and maintenance of steel structures by paint and are based upon forty years of successful experience. The folder also exhibits the four shades of Dixon's silicon-graphite paint manufactured by this company.

Exhaust Fans.—A new catalogue, No. 149, has been issued by the American Blower Company, Detroit, Mich. It is devoted to the "A. B. C." exhaust fan for the removal and conveying of shavings and dust, the removal of smoke and for use in connection with heating and drying apparatus. The pamphlet also presents dust separators, dry kiln equipment, and includes convenient tables of information.

The Jeffrey Manufacturing Company, Columbus, Ohio, have issued Catalogue No. 19, illustrating coal cutters and coal drills, operated by electricity and compressed air; electric locomotives for mine and surface haulage, and complete electric power plants for mining properties. It is a finely illustrated pamphlet of 127 pages, showing a very large variety of this equipment and giving information for its use.

A NEW LIQUID GLUE.

A new and remarkable adhesive known as Army and Navy Glue attracted attention at the recent conventions at Saratoga. It is a liquid glue, but is not derived in any way from fish. The inventor, J. W. Wachter, a leather worker, in the employ of the United States Government at Washington, produced it in an effort to secure a more satisfactory adhesive than those previously available. As a result he produced a glue which is satisfactory for leather, wood and other gluing, and one which sustained a weight of 327 lbs. per sq. in. of surface of steel bars glued to each other. Having occasion to encase some shells with leather, Mr. Wachter used this glue, and though the shells weighed 1,150 lbs. and were rolled about the shop, the leather adhered perfectly and accomplished the desired results. Soon after this the Navy Department, after experimenting with the best glues on the market, adopted this, which was manufactured by Mr. Wachter as an employee, and for which he received no compensation other than his wages. During the recent war this glue was used in making ignition bags which form a part of all the fixed ammunition in the navy. Realizing the importance of the discovery, Mr. Wachter patented it and has placed it on the market. Its superiority lies not only in its great tenacity and in the wide range of substances with which it may be used, but in its strength under varying conditions of heat, cold, dampness and pressure, also it does not sour or spoil by standing, and it does away with the necessity of boiling and heating ill-smelling glue pots. There is a bright outlook for this liquid glue. Those who investigate it as a representative of this journal has done will find the investigation profitable. This is an animal glue in liquid form and is certainly a remarkable achievement. The Wachter Manufacturing Company, Baltimore, Md., will supply additional information.

NEW QUARTERS FOR THE BRODERICK & BASCOM ROPE COMPANY.

A careful study of the subject of wire rope and cable for many years has enabled them to put on the market a first-class article in their power steel and patent steel ropes. Among the many uses for this rope may be mentioned: guy ropes for derricks, wire tramways, endless wire ropeways for transportation of material over difficult roads, hoisting from deep shafts or inclined planes, transmission of power, switch ropes, etc., etc.

As an evidence of the "staying qualities" of this rope, the com-

pany calls attention to a letter recently received from the Greenview Coal & Mining Co., of Greenview, Ill., in which G. W. Hatch, secretary, says:

"Replying to your favor of December 31st, regarding the service of our 1-inch 19-wire power rope, purchased of you, is giving us. It has given us excellent satisfaction. On December 16th one of the sheaves and shaft broke and dropped a cage loaded with one car of coal, weighing at least 3,500 lbs., ten or twelve feet. The rope remained intact and saved the cage from going to the bottom if safety catches had failed to hold. We can cheerfully recommend your steel power rope."

In addition to wire rope, the company also handles manila rope of all sizes, and carry a full line of *tackle* and *snatch blocks* for manila and wire ropes, all sizes.

EQUIPMENT AND MANUFACTURING NOTES.

The 20-stall roundhouse of the Norfolk & Western Railway at Portsmouth, Ohio, has been equipped with a "hot blast" system of heating, the apparatus consisting of a large exhaust fan direct-connected to a horizontal engine and drawing air through a steam-coil heater built up of 1-in. steam piping on cast iron sections. From this apparatus air is distributed throughout the roundhouse by brick flues and galvanized iron piping, so arranged that heated air may be delivered into each engine pit. It will thus serve to melt off snow or ice from incoming locomotives when that is required. From the pits the heated air rises vertically, so that there is no trouble from smoke or steam in the inhabited zone of the building. On account of the dry character of the air supplied by the system, all moisture due to the melting of snow of ice is quickly evaporated, making it possible to work on an engine without discomfort within a very short time after it enters the building. During warm weather it is possible to operate the fan without steam in the heater, and in that manner provide a very thorough ventilation of the building, which is rarely accomplished in roundhouses equipped with the ordinary direct system of steam or hot-water heating. Other advantages, as compared with the direct system, are that there is no piping scattered about the building to freeze or burst in cold weather, there are no joints to leak, and there is no danger of fire from the proximity of steam pipes to inflammable materials. Since the piping is all concentrated in a steel-plated housing, where the velocity of the air passing over it is very high, much less length of pipe is needed than would otherwise be necessary. The above described equipment has been designed and installed by the B. F. Sturtevant Company, of Boston.

The Holland Company, with main offices in the Great Northern Building, Chicago, Ill., and who are well known through their Martin Metallic Flexible Joint and Holland Journal Box, announce the removal of their San Francisco office from 508 Market street to 12 Fremont street. The new location affords the excellent advantage of being on the ground floor as well as permitting basement storage, where they will carry a complete stock of the H. W. Johns-Manville Company's asbestos products, for which they are exclusive agents on the Pacific Coast, together with the Dake Engine Company's high speed engine and pneumatic chain hoists. Mr. J. C. Martin, Jr., vice-president of the company, will be manager of the San Francisco branch, with Mr. S. P. Russell, Jr., assistant manager.

The exhibit of the Corrington Air Brake Co. at the recent conventions marks their first introduction to our railroad friends. They show a triple with attachment for recharging auxiliary reservoirs while brakes are applied, and insuring a full reservoir when brakes are released. A high speed reducing valve and compact form of brake valve were included, the former very small, compact and capable of attachment to the brake cylinder without pipe connections, and the latter with feed valves for ordinary and high speed service. This company furnishes complete brake apparatus for railroad service and thoroughly interchangeable with the existing systems.

The North-Eastern Railway Company, of England, recently conducted a series of important brake trials on its lines, which at one point attain an elevation of 1,800 feet above sea level, and is one of the steepest sections of railway in the United Kingdom. Forty heavy coal cars comprised the train, each car being equipped with Westinghouse quick-acting brake. Despite high speed, unfavorable climatic conditions, and traveling on the down grade, the train was brought to a stand in a very short distance, the application of power on both front and rear wheels of the train being practically simultaneous. The trials are said to have been highly satisfactory.

The American Steam Gauge and Valve Manufacturing Company, Jamaica Plains, Boston, tendered the annual dinner to the sales department on the evening of July 1, at the Hotel Essex, Boston. This is in accordance with the wide-awake policy of the company, a part of which is to get all of the traveling men and branch house managers together with the home office, for an annual conference about the business and closing with a banquet. This is a pleasant and very important custom, indicating up-to-date business methods.

The value of graphite as a lubricant is well understood. The United States Graphite Company, Saginaw, Mich., confidently offer their "No. 205 Lubricating Graphite" for use of all who have to do with engines or machinery. It is pure and carefully prepared. Besides being used as a lubricant, it may be mixed with oil and used as a roof or stack paint or pipe-joint compound. A sample quarter pound will be furnished free for trial, and also complete instructions for use of graphite for lubrication. Further information may be had from the manufacturers.

Mr. William Burlingham has accepted an appointment as chief engine designer with the B. F. Sturtevant Company, of Hyde Park, Mass., resigning a position in the United States Inspection Office with the Wm. R. Trigg Company, of Richmond, Virginia. Mr. Burlingham has previously been associated with the Bath Iron Works, the General Electric Company, the Southwark Machine & Foundry Company, and the Newport News Shipbuilding & Dry Dock Company. He has also served on Mr. T. A. Edison's staff at the East Orange laboratory and is a graduate of the Worcester Polytechnic Institute.

The Consolidated "Axle Light" equipments of electric car lighting are coming into increasing use on the finest cars constituting some of the best and fastest trains of leading railway lines, including Pullman cars. All private Pullman cars and many business cars of railway officials, as well as private cars of individuals, are equipped with the Consolidated "Axle Light" system of electric lights. These "Axle Light" equipments are also beginning to be used quite extensively on the railway systems of Great Britain and Europe.

The Lunkenheimer Co., Cincinnati, Ohio, tendered the forty-first annual outing to 700 employees and their families July 18 at Woodsdale Island Park. The total number, including children, reached about 2,000. The entire expense of these pleasant outings is borne by the company.

The Allis-Chalmers Company has been awarded a contract for twenty-eight No. 8 Gates ball mills, thirty-nine 5 by 22-ft. Gates tube mills, and twenty-four rotary kilns of special design for the cement plants now building for the United States Steel Corporation at the Illinois Steel Company's plant at South Chicago.

Westinghouse-Parsons steam turbines will be used to drive the 50,000 kw. of electrical machinery for the new Rapid Transit subway and elevated system now under construction in Philadelphia. The machinery contract has just been closed by Westinghouse, Church, Kerr & Co.

Thomas Chalmers, father of W. J. Chalmers, chairman of the executive committee of the Allis-Chalmers Co., died July 13 and was buried Thursday, July 16. Thomas Chalmers was the founder of the firm of Fraser & Chalmers, which firm was recognized as the world's largest producer of mining machinery.

A. Leschen & Sons Rope Company, manufacturers of wire rope and aerial wire rope tramways, have moved their San Francisco office to the Rialto Building, corner of New Montgomery and Mission streets, San Francisco.

The Acme Supply Company, 100 Lake street, Chicago, has succeeded to the business heretofore conducted under the firm name of G. S. Wood & Co., consisting of Messrs. H. H. Schroyer, G. S. Wood and S. Woodworth.

Mr. D. G. Farragut has been appointed to represent the Pressed Steel Car Company in Mexico, with headquarters at Calle de Gante 8, City of Mexico, where all the business of this company in the Republic of Mexico will be managed.

The American Blower Company have taken contracts for heating apparatus for the new roundhouse of the Baltimore & Ohio at Keyser, W. Va., and for induced draft apparatus for the Chicago, Burlington & Quincy at Aurora, Ill.